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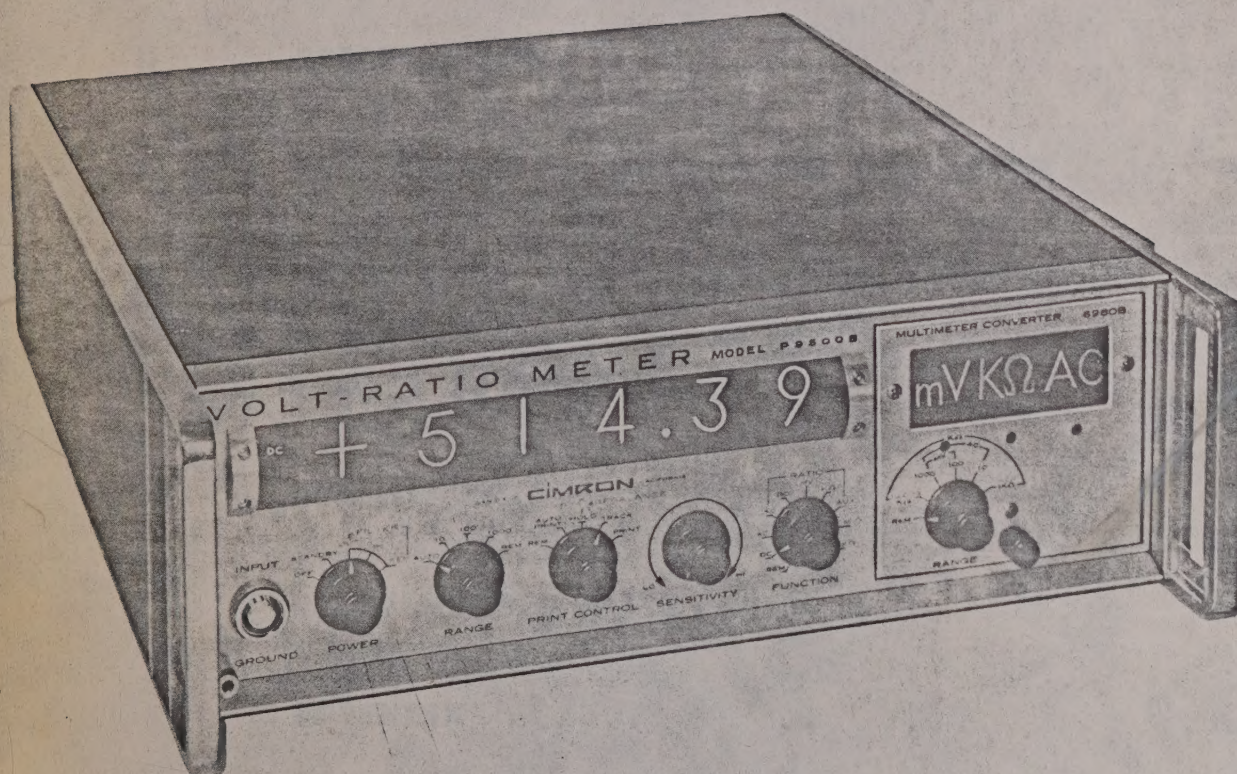
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**SERIES P9000B
DIGITAL VOLT- AND
VOLT-RATIO METER
INSTRUCTION MANUAL**

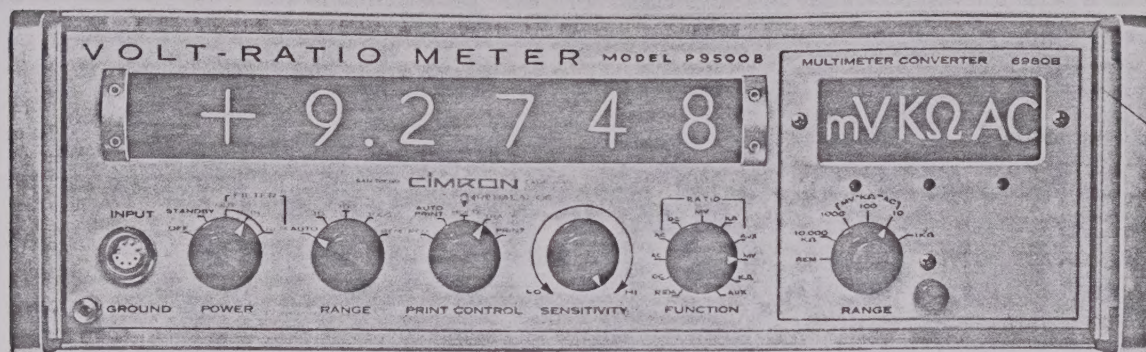


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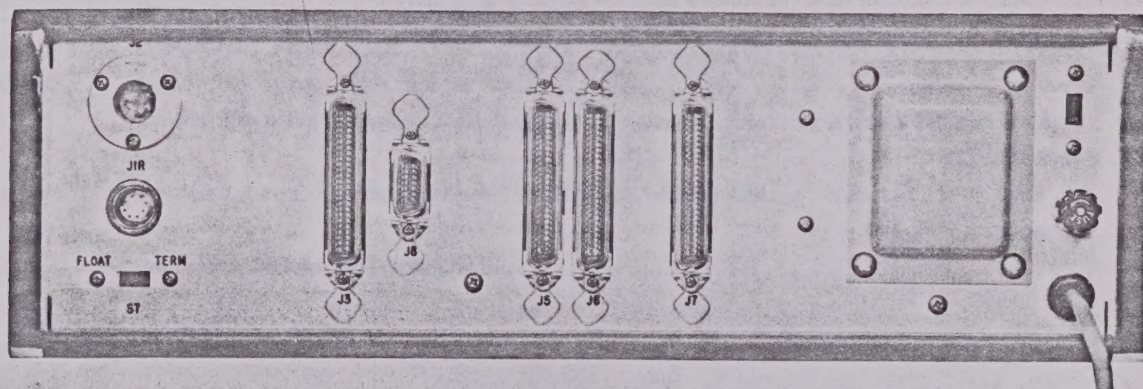
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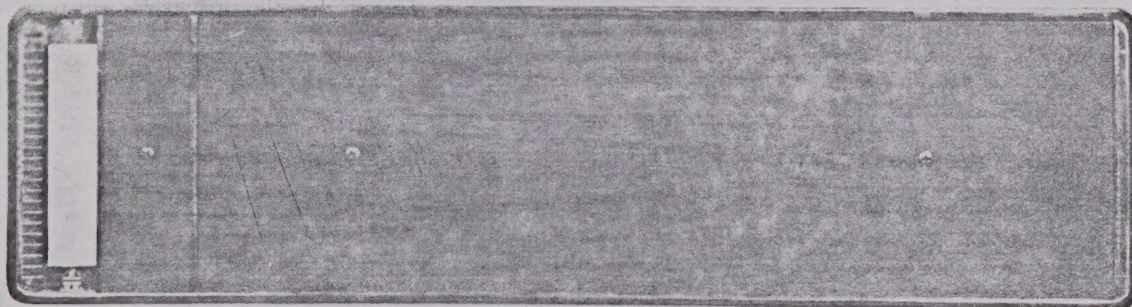
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REAR VIEW



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SECTION I

INTRODUCTION

This manual contains complete operation, calibration, and maintenance instructions for all models of the Cimron Series P9000B Digital Voltmeters and Volt-Ratio Meters. A brief description of each section of this manual is given in Table I.

The Cimron Series P9000B consists of Models 9200B, 9300B, 9400B and 9500B instruments. The 9200B Digital Voltmeter, and all other models of the series, are extremely accurate five-digit instruments which measure DC voltages from 0 to ± 1000 volts in three manual and automatic ranges of $\pm 10V$, $\pm 100V$, and $\pm 1000V$ full scale. By addition of appropriate plug-in accessories, measurement capabilities of the instruments can be expanded to include AC voltages, millivolt DC voltages, and resistance. All models present a visual indication of the value of the input signal.

Model 9300B Digital Volt-Ratio Meter also measures DC ratios from 0 to 100:1 in three manual and automatic ranges of 1:1, 10:1, and 100:1.

Model 9400B Digital Voltmeter provides electrical outputs in the form of 10-line decimal contact closures suitable for operating a printer or other recorder. Various BCD code outputs are available on special order.

Model 9500B Digital Volt-Ratio Meter measures DC ratios from 0 to 100:1 in three manual and automatic ranges of 1:1, 10:1, and 100:1. The Model 9500B also provides electrical outputs in the form of 10-line decimal contact closures suitable for operating a printer or other recording device. Various BCD code outputs are available on special order.

Solid state components are used exclusively, with the exception of the critical circuitry associated with the digital potentiometer. These circuits employ sealed reed relays as the precision switching elements. Virtually all components are mounted on plug-in printed circuit boards, providing an ease of operational and preventive maintenance not usually associated with complex electronic test equipment.

TABLE I
Synopsis of Information in Each Section of the Manual.

SECTION	TITLE	CONTENTS
SECTION I	INTRODUCTION	
SECTION II	SPECIFICATIONS	Specifications which describe in detail the physical and electrical characteristics of the Series 9000 Digital Voltmeters and Digital Volt-Ratiometers.
SECTION III	PRELIMINARY INSPECTION AND OPERATION	This section explains the purpose of the front panel controls and sets forth an inspection procedure for use upon initial receipt of the instrument.
SECTION IV	CALIBRATION AND SPECIFICATION VALIDATION	This section contains a complete calibration procedure, and a method of validating each specification set forth in Section II.
SECTION V	THEORY OF OPERATION	This section contains two parts. The first gives a general description of the principle of operation. The second provides a detailed electrical analysis of each assembly.
SECTION VI	MAINTENANCE	This section contains schematics, component location, and a parts list for each assembly. Oscilloscope pictures of wave forms at critical test points are included to assist in the location of trouble areas.
SECTION VII	RECOMMENDED SPARE PARTS	This section contains recommendations for spare parts and assemblies required to maintain a Series 9000 Digital Voltmeter or Volt-ratiometer for a period of one year.
APPENDIX		List of Abbreviations, List of Manufacturers, and Warranty.

SECTION II

SPECIFICATIONS

INPUT CIRCUIT:	The input signal leads are floating and isolated from case, power line ground and printer output. A guard shield is employed to guarantee maximum input isolation and common-mode rejection.
COMMON MODE REJECTION:	10,000,000:1 (140 db) at DC and 1,000,000:1 (120 db) at 60 cps with 1000 ohms of unbalance in either input lead. Input may be floated up to 1000V DC or peak AC (707V RMS).
NORMAL MODE REJECTION:	At 60 cps, filter out: 54 db, filter in: 74 db.
VOLTAGE RANGE:	0.0000 to ± 999.99 VDC in three ranges of ± 9.9999 , ± 99.999 and ± 999.99 V DC. Resolution of 10 microvolts, 1 microvolt and .1 microvolt may be accomplished by use of appropriate plug-in preamplifier.
RANGE SELECTION:	Manual, programmable and automatic.
POLARITY SELECTION:	Automatic.
DISPLAY:	Full five digits using long life readout tubes mounted behind non-reflecting polarizing screen.
ACCURACY:	Within $\pm(0.001\%$ of full scale $+0.005\%$ of reading) after calibration to known standards.
STABILITY:	Short term (24 hours) $\pm(0.001\%$ of full scale $+0.005\%$ of reading.) Long Term (1 year) $\pm(0.001\%$ of full scale $+0.01\%$ of reading.)
RESOLUTION:	0.001% of full scale (= 1 digit).
INPUT RESISTANCE:	Greater than 10,000 megohms at balance on 9.9999V DC range (instrument will measure voltage from a 10 megohm source); greater than 10 megohms independent of balance on 99.999 and 999.99V DC ranges.

RESPONSE TIME: 330 milliseconds average: Maximum balancing time without range and polarity change is 750 milliseconds. Maximum balancing time with range and polarity change is 900 milliseconds. Minimum balancing time is under 7 milliseconds. With filter, balancing times are increased by a factor of 2 to 3.

EXTREME TEMPERATURE RANGE: 0° to +50°C.

TEMPERATURE COEFFICIENT: Derate accuracy (0.0001% of full scale +0.0005% of reading) per °C. Derate resolution 1 digit for 20°C temperature rise.

REMOTE CONTROLS: Range (decimal point), function, filter and print control functions may be controlled by external isolated contact closures.

DIGITAL OUTPUT (Model P9400B and P9500B only) The complete digital reading including range and polarity is available on rear mounted connectors. Output information is provided by isolated contacts of reed relays in ten line decimal code. Standard BCD output models also available. Contact ratings are 250V or .5a with a 10 volt-amps maximum.

POWER REQUIREMENTS: 105 to 125/210 to 250 volts, 50 to 400 cps, approximately 30 volt-amps. Derate accuracy 0.002% of reading per 10% line voltage change.

WEIGHT: 36 lbs. net; 40 lbs. shipping.

RATIO OPERATION (Model P9300B and P9500B only)

RANGE: .00000:1 to 99.999:1 in three manual, programmable or automatic ranges of .99999:1, 9.9999:1 and 99.999:1.

ACCURACY: Within $\pm(0.001\%$ of full scale +0.003% of reading.)

EXTERNAL REFERENCE RANGE: Less than ± 1 volt DC to ± 100 volts DC.

INPUT IMPEDANCE: Greater than 10,000 megohms at balance on the .99999:1 range; greater than 10 megohms independent of balance on the 9.9999:1 and 99.999:1 ranges.

INPUT RESISTANCE FOR EXTERNAL REFERENCE: 100,000 ohms.

POLARITY: Automatic bi-polar.

RESOLUTION (DIGITS): 10/(ref. voltage) or 1 digit whichever is greater.

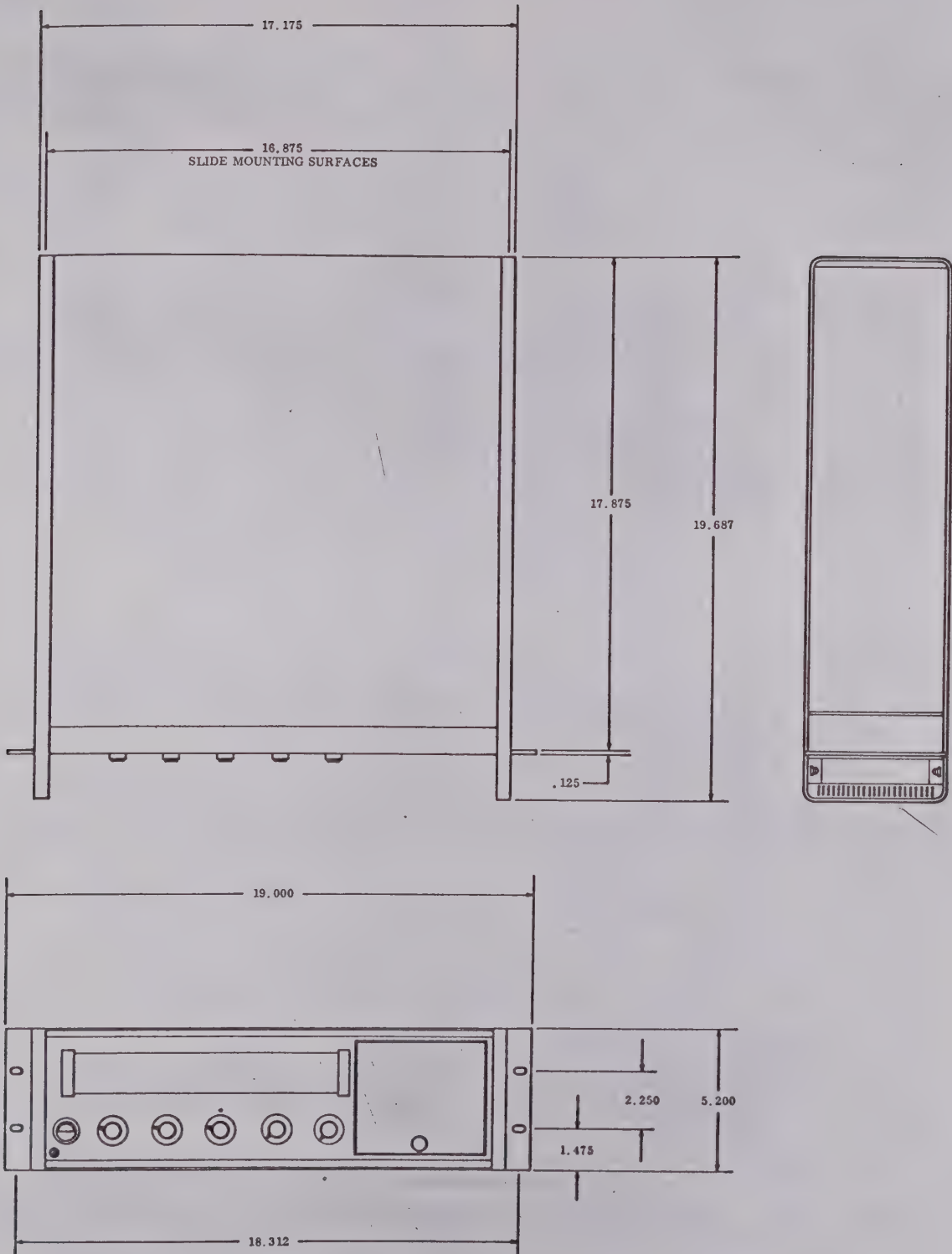


Figure 2-1. Outline Drawings, Series 9000B Digital Volt and Volt-Ratio Meter.

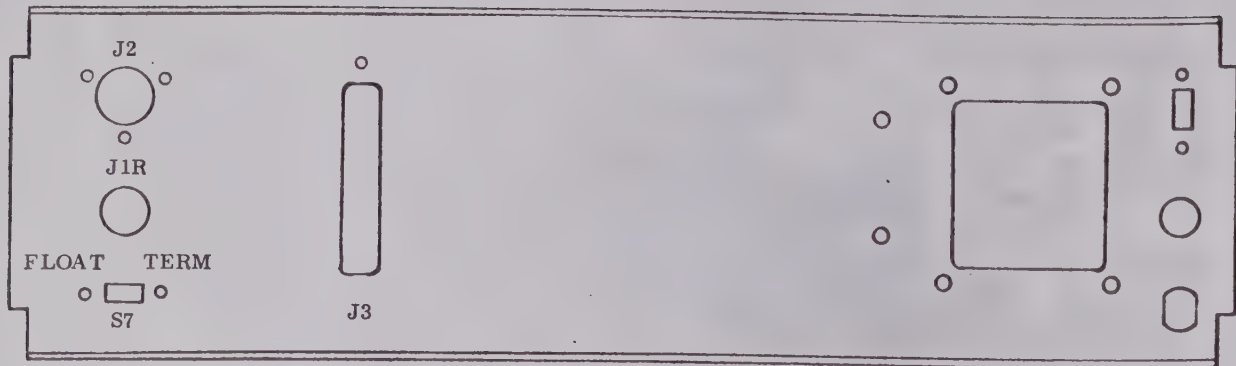


Figure 2-2. Rear Connectors, 9200B and 9300B.

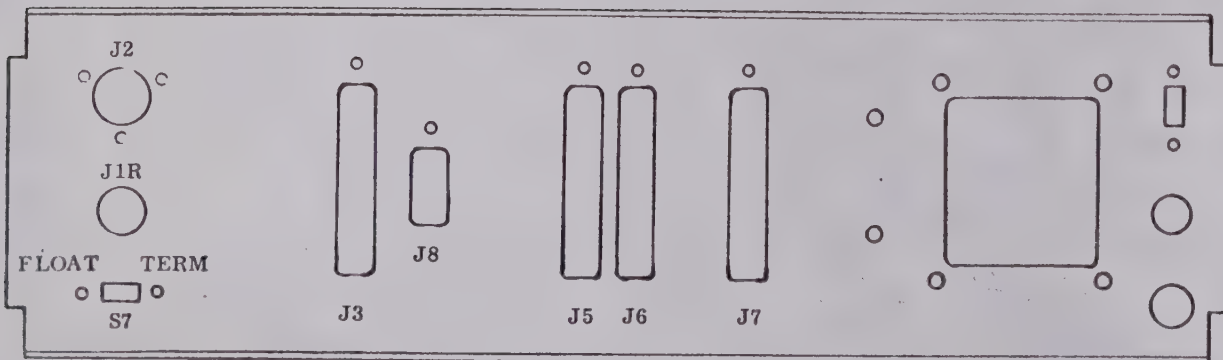


Figure 2-3. Rear Connectors, 9400B and 9500B.

SECTION III

PRELIMINARY INSPECTION AND OPERATION

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INSPECTION AND OPERATION UPON RECEIPT

The digital voltmeter is aligned, calibrated, and tested under severe environmental conditions prior to shipment. It is ready for immediate use upon receipt. The following checks should be made, however, to assure that the instrument has suffered no damage in shipment.

1. Visually inspect the shipping container prior to acceptance from the carrier. Note any damage to the shipping container on the carrier's receipt for the carrier's agent to sign.
2. Visually inspect for damage upon removing the instrument from the shipping container.
3. Remove the top cover and guard shield, and check for loose or broken components. Check to see that the printed circuit boards are mated with their connectors and are well seated.

4. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier within 15 days of receipt. All shipping containers and filler material must be maintained for inspection.
5. Remove the power fuse from its packing container and install the fuse in the fuse holder. Turn the POWER switch to OFF, the FUNCTION switch to DC, SENSITIVITY control to HI, the DC RANGE switch to AUTO, and the PRINT CONTROL switch to TRACK.

CAUTION

To avoid damaging instruments that have either a millivolt or resistance measuring capability, or both, do not apply voltage to the input leads when the instrument is in a resistance measuring mode or more than 100 VDC or peak AC when the instrument is in a millivolt measuring mode.

WARNING

Signal input connectors are available on the front and rear panels and are wired in parallel. Cover the unused connector with its safety cover to protect operating personnel from electric shock.

- 7. Insert the power cord into a three-wire 115V AC, 60 cps, single phase power source. Turn the POWER switch to the ON position.

NOTE

Should the instrument be used on a 230V line, position the switch above the fuse on the rear panel to 230.

- 8. Position the RANGE switch sequentially to the 10, 100, and 1000 volt positions, and observe that the decimal point shifts to proper position.
- 9. Connect a low voltage battery between the red and black input leads. The readout should indicate the voltage and polarity of the battery.

- 10. Reverse the polarity of the input signal; the readout should indicate the polarity change.
- 11. Remove the battery and short the input leads together. The instrument should return to zero.

NOTE

The liability of Cimron under the warranty is negated if the instrument is improperly repaired. If trouble is experienced during the above test, refer to the appendix for warranty instructions before attempting repair.

OPERATING CONTROLS

All of the controls necessary for normal operation are located on the front panel and are identified in figure 3-1. The function of each control is outlined in Table II.

CAUTION

Do not insert plug-in accessories in the digital voltmeter while power is applied.

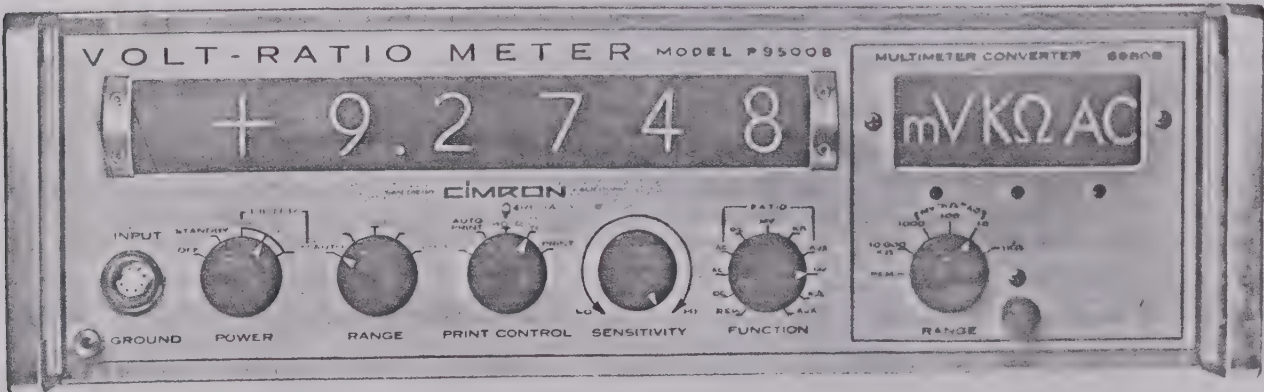


Figure 3-1. Front Panel Operating Controls.

TABLE II
Front Panel Controls and Their Functions.

CONTROL	POSITION	FUNCTION
POWER	OFF	AC power is removed from the instrument.
	STANDBY	AC power is applied, logic circuits are held inoperative.
	FILTER OUT	AC power is applied, input filter is out.
	FILTER IN	AC power is applied, input filter is in.
	FILTER REM	AC power is applied, input filter is remotely controlled.
RANGE	AUTO	The instrument accepts any voltage between 0.0000 and $\pm 999.99V$ and automatically ranges to provide the proper input attenuation and correct decimal point position for maximum resolution.
	10	Low range scale. 100 uv sensitivity. Used when auto ranging is not desired.
	100	Medium range scale. 1 mV sensitivity. Used when auto ranging is not desired.
	1000	High range scale. 10 mV sensitivity. Used when auto ranging is not desired.
	REM	Provides for remote selection of the 10, 100, 1000, or AUTO ranges.
PRINT CONTROL (models 9400B and 9500B only)	REM	A single relay control line is externally grounded to establish a TRACK mode; absence of a ground on this line places the instrument in the HOLD mode.
	AUTO PRINT	The instrument tracks the input signal and upon reaching a balance issues a print command signal through a rear connector.
	HOLD	Logic circuits are held inoperative unless REBALANCE pushbutton is pressed. This allows a one-shot operation, where the DVM seeks a new null and issues a print command upon completion. At this point, the DVM is held inoperative again.
	REBALANCE	The DVM finds a new null, issues a print command, and returns to HOLD mode.
	TRACK	The instrument tracks the input but does not issue a print command.

TABLE II

Front Panel Controls and Their Functions (Cont'd).

CONTROL	POSITION	FUNCTION
PRINT CONTROL (Cont'd)	PRINT	The PRINT position is a momentary contact closure which results in a print command signal at the time of closure. This command is issued without regard for the balance condition of the instrument.
SENSITIVITY	HI THRU LO	HI is equal to 100uv (maximum sensitivity). The sensitivity is decreased as the control is rotated toward LO.
FUNCTION	REM	Provides for selection of any function by remote contact closure.
	DC	The DVM measures voltages from 0.0000 to $\pm 999.99V$ DC.
	AC	The input signal is connected to the AC converter plug-in accessory to measure voltages from 0.0000 to 999.99V AC.
	AC RATIO	The internal reference supply is disconnected. An external DC reference supply may be connected across the reference potentiometer for AC to DC ratio measurement.
	DC RATIO	The internal reference supply is disconnected. An external DC reference supply may be connected across the reference potentiometer for DC to DC ratio measurement.
	MV RATIO	The internal reference supply is disconnected. An external DC reference supply may be connected across the reference potentiometer for MV to DC ratio measurement.
	K Ω RATIO	The internal reference supply is disconnected. An external DC reference supply may be connected across the reference potentiometer for K Ω to DC ratio measurement.
	AUX RATIO	The internal reference supply is disconnected. An external DC reference supply may be connected across the reference potentiometer for ratio measurement.
	MV	The input signal is connected to the MV preamplifier plug-in accessory for measurement of voltages from ± 0.0001 to ± 9.9999 MV.
	K Ω	The input signal is connected to the ohms-DC converter plug-in accessory for measurement of resistances from 0 to 9.9999 M Ω .
	AUX	For use of any Cimron Series B plug-in accessory; DC stable source, high voltage input, AC converter, ohms-DC converter, MV preamplifier, and others.

SECTION IV

CALIBRATION AND SPECIFICATIONS VALIDATION

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REFERENCE STABILIZATION

To realize the full accuracy capability of the instrument, it is necessary to calibrate the internal reference supply against an extremely accurate voltage source and to adjust the input divider of the instrument to provide an accurate 10:1 and 100:1 signal reduction ratio. The following calibration procedure is based upon the assumption that the external DC power source used exhibits the required stability and its output is known to be 0.003% or better.

Prior to calibration the instrument must be placed in the environment of the calibration area for

sufficient time to temperature stabilize. Excessive temperature gradients resulting from a change in environment may cause thermal-voltages to be generated which could affect calibration. A stabilizing time of one hour for each 10°C change in temperature is required.

After the instrument is turned on, a period of 90 minutes must be allowed for the reference supply to stabilize. The output voltage of the reference supply is within 0.01% of its final value in a relatively short period of time. However, if the ultimate accuracy is to be realized, complete stabilization is necessary before calibration is attempted.

ADJUSTMENT

The following adjustments when required should be accomplished in the order described below. These adjustments are considered operational in nature in that they do not affect the accuracy of the instrument. For this reason, adjustment should be required only after major changes such as the replacement of a plug-in assembly. When complete readjustment and recalibration is required, adjustment procedures should be accomplished prior to calibrating the reference supply and input divider (attenuator).

The following equipment is required to perform these adjustments:

1. Precision, stable DC power supply.
2. Linear voltage divider.
3. Dual beam oscilloscope with a sensitivity of 200 microvolts per centimeter.

Remove the top cover to expose the large inner guard shield. All test points required for the alignment and calibration of the Series 9000B instruments are identified on the shield, as shown in figure 4-1.

Position the instrument controls as follows:

FUNCTION	DC
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER	FILTER IN

To review the necessary waveforms, position the oscilloscope controls as follows:

TRIGGER SELECTOR	EXTERNAL DC (+)
TIME/CM	2MS/CM
SENSITIVITY	1V/CM (X1 PROBE)

BALANCE ADJUSTMENT

Connect the oscilloscope to the instrument as follows:

SIGNAL COMMON	COMMON
CHANNEL A INPUT	TP13
EXTERNAL TRIGGER	TP14

Connect the power supply, voltage divider and instrument as shown in figure 4-2 and proceed as follows:

1. Adjust the DC power supply for +1 volt output.
2. Adjust the output of the voltage divider for a null condition (figure 4-3) at 500mv.
3. Observe the reading on the instrument and the exact setting of the voltage divider.
4. Increase the setting of the voltage divider by 100 microvolts.
5. Note that the instrument reading increases one digit.
6. Adjust the output of the voltage divider to obtain a null condition.
7. Observe the voltmeter reading and the exact setting of the voltage divider.
8. Decrease the voltage divider output by 100 microvolts.
9. Note that the voltmeter reading decreases by 1 digit.
10. Vary the Balance Adjustment for best equality of up and down sensitivities.

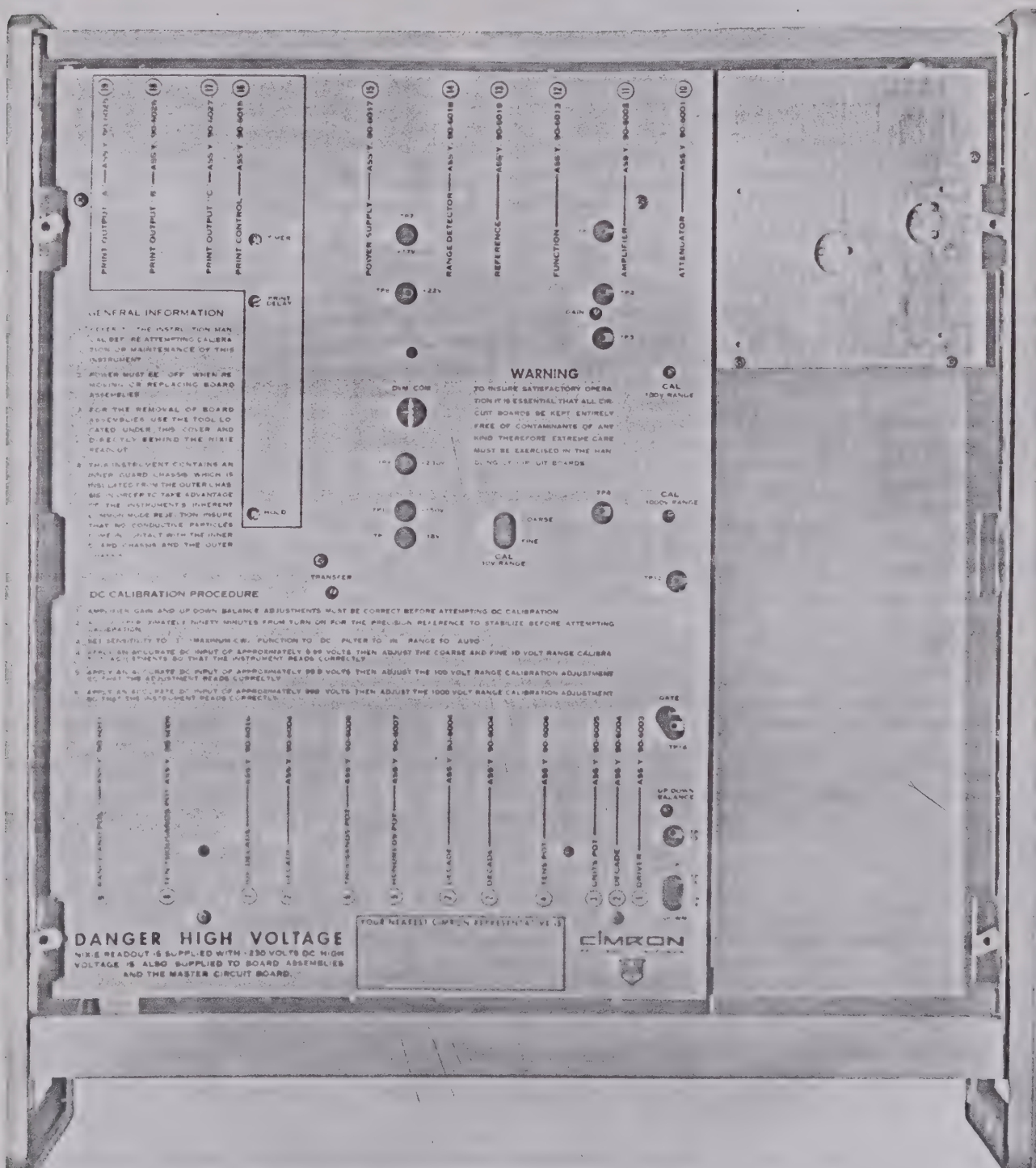


Figure 4-1. Calibration Controls, Series 9000B.

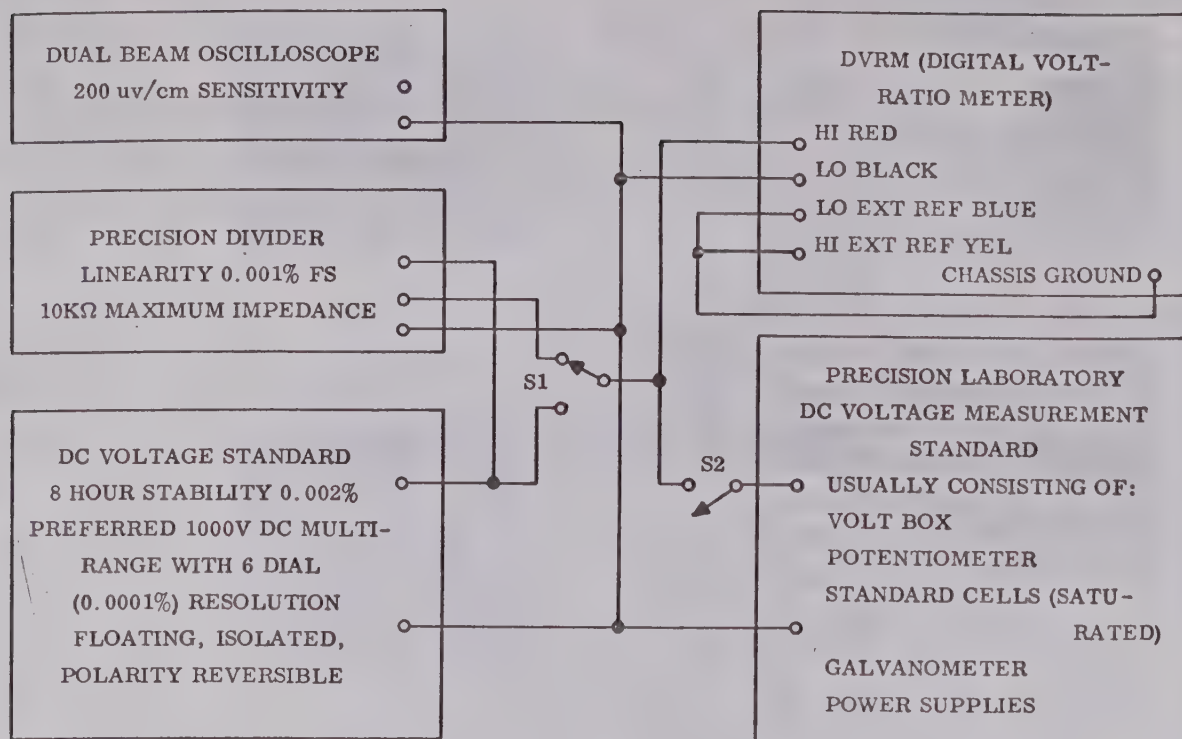


Figure 4-2. Calibration Equipment Setup.

GAIN ADJUSTMENT

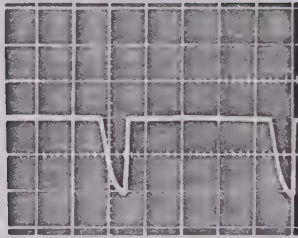
Connect the oscilloscope as follows:

SIGNAL COMMON	COMMON
CHANNEL A INPUT	TP13
EXTERNAL TRIGGER	TP14

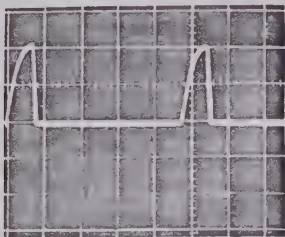
Connect the power supply, voltage divider and instrument as shown in figure 4-2.

1. Adjust the DC power supply for +1 volt output.
2. Set the precision voltage divider for 0.5 volt output.
3. Slowly increase and then decrease the output of the voltage divider.

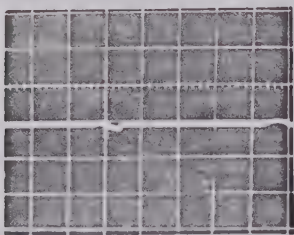
4. Observe that either a positive or negative pulse can be made to appear at the demodulator output terminal (TP13). Examples of such errors are shown in figure 4-3.
5. Adjust the output of the voltage divider for minimum amplitude pulses.
6. Observe the reading on the instrument and the exact setting of the voltage divider.
7. Increase the setting of the voltage divider by 100 microvolts.
8. Vary the Gain Adjustment to cause the instrument reading to increase by 100 microvolts.



Negative pulse due to input voltage lower than DVM reading.



Positive pulse due to input voltage higher than DVM reading.



Null.

Figure 4-3. Demodulator Output, TP13.

TRANSFER ADJUSTMENT

Connect the power supply, voltage divider and instrument as shown in figure 4-2.

1. Adjust the DC power supply for an output of 3.0 volts in a positive polarity.
2. Adjust the voltage divider as required to obtain a reading of +0.9999 on the instrument.
3. Gradually increase the voltage divider output from null until the voltmeter has progressed through the decade transfer to a reading of 1.0000.
4. Reverse the polarity of the power supply and repeat paragraphs 1 through 3.
5. Vary the Transfer Adjustment for a compromise setting which will allow the best transfers. If improperly positioned, the Transfer Adjustment will cause the voltmeter to oscillate between 0.9999 and 1.0000 in one or the other polarity.

REFERENCE SUPPLY CALIBRATION

To accurately calibrate the reference supply the following test equipment is required:

1. Precision, stable DC power supply.
2. Dual beam oscilloscope with a sensitivity of 200 microvolts per centimeter.

Remove the top cover to expose the large inner guard shield. All testpoints required for the calibration of the instrument are identified on the shield.

To review the necessary waveforms, connect the oscilloscope as follows:

9. Adjust the voltage divider to obtain a new null condition. Observe the voltmeter reading and voltage divider setting. Repeat paragraphs 7 through 9 to obtain an optimum adjustment.

SIGNAL COMMON	COMMON
CHANNEL A INPUT	TP13
EXTERNAL TRIGGER	TP14

Position the oscilloscope controls as follows:

TRIGGER SELECTOR	EXTERNAL DC (+)
TIME/CM	2MS/CM
SENSITIVITY	1V/CM (X1 PROBE)

Position the instrument controls as follows:

FUNCTION	DC
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER	FILTER IN

Connect the voltmeter input (figure 4-2) directly to the DC power supply, using switch S1.

SIGNAL HI (RED)	+ DC OUTPUT
SIGNAL LO (BLACK)	- DC OUTPUT
EXTERNAL REFERENCE	CHASSIS GROUND

To accurately calibrate the reference supply proceed as follows:

1. Adjust the DC power supply for an output of 9.9000 volts $\pm 0.01\%$.
2. Note the reading displayed on the instrument and observe the null. If the reading differs from the value of voltage in step 1, sequentially adjust the Coarse and Fine trim potentiometers for the 10V range to obtain the correct reading. After adjusting, tap each control lightly to assure that the wiper arm is properly seated. This adjustment should be positioned to within ± 1 digit of the power supply voltage.

ATTENUATOR CALIBRATION

The attenuator adjustment consists of setting the trim potentiometers in the input divider to provide an accurate 10:1 signal reduction on the 100V range and a 100:1 signal reduction on the 1000V range. The following test equipment is required to accurately adjust the input divider.

1. Precision, stable, DC power supply.
2. Dual beam oscilloscope with a 200 micro-volt sensitivity.

To review the necessary waveforms connect the oscilloscope as follows:

SIGNAL COMMON	COMMON
CHANNEL A INPUT	TP13
EXTERNAL TRIGGER	TP14

Position the oscilloscope controls as follows:

TRIGGER SELECTOR	EXTERNAL DC (+)
TIME/CM	25MS/CM
SENSITIVITY	1V/CM (X1 PROBE)

Position the instrument controls as follows:

FUNCTION	DC
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER	FILTER IN

Connect the output of the power supply (figure 4-2) to the input of the instrument using switch S1.

SIGNAL HI (RED)	+ DC OUTPUT
SIGNAL LO (BLACK)	- DC OUTPUT
EXTERNAL REFERENCE	CHASSIS GROUND

To adjust the range attenuator proceed as follows:

1. Adjust the DC power supply to obtain an output of 99.900 volts $\pm 0.01\%$.
2. Note the voltage displayed on the instrument readout. If the reading differs from the power supply voltage by more than $\pm 0.01\%$, adjust the 100V Range trim potentiometer to obtain a reading within tolerance.
3. Adjust the DC power supply to obtain an output of 999.00 volts $\pm 0.01\%$.
4. Note the voltage displayed on the instrument readout. If the reading differs from the power supply voltage by more than $\pm 0.01\%$, adjust the 1000V Range trim potentiometer to obtain a reading within tolerance.

RATIO OPERATION

Models 9300B and 9500B are Digital Volt-Ratio Meters designed to compare an unknown voltage with a known external reference voltage. The instrument displays the quotient of the unknown voltage divided by the external reference voltage. The external reference voltage may vary from $\pm 1V$ to $\pm 100V$. The unknown voltage, however, must be of lesser value than the external reference voltage.

The positive and negative external reference voltages are connected to a 5-wire signal input cable, Cimron Part No. 90-5004-3. The 5-wire cable allows the positive and negative external reference voltages to be connected to front panel signal input connector J1F or rear panel signal input connector J1R. The reference voltage is connected to the reference potentiometer. When the RANGE switch is positioned to AUTO the instrument automatically selects the range and polarity of the external reference voltage.

The following test equipment is required to demonstrate the ratio capability of the instrument:

1. Precision, stable DC power supply.
2. Voltage Divider with linearity to 0.005%.

Position the instrument controls as follows:

FUNCTION	DC RATIO
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER	FILTER IN

Connect the equipment as shown in figure 4-4 and proceed as follows:

1. Adjust the power supply to obtain 10.0V output.
2. Adjust the voltage divider to a selected voltage ratio.

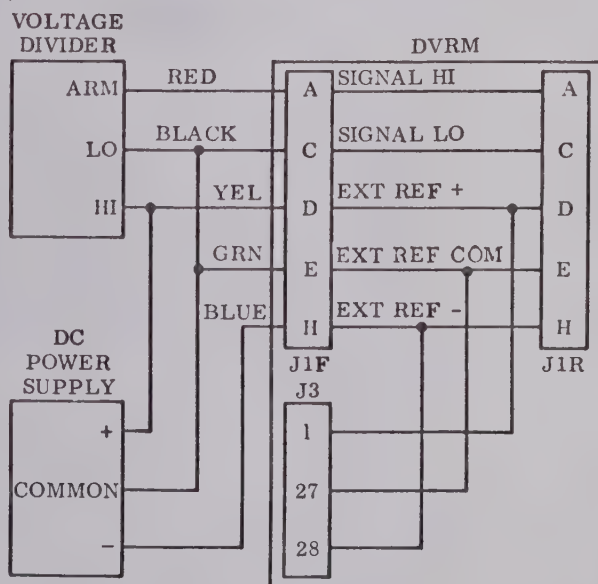


Figure 4-4. Ratio Operation Test Setup.

3. Note that the reading on the instrument does not vary from the selected ratio by more than $\pm 0.005\%$ of reading $\pm 0.002\%$ of full scale.
4. Adjust the power supply to obtain 3.0 volts output.
5. Adjust the voltage divider to a selected voltage ratio.
6. Note that the reading on the instrument does not vary from the ratio selected by more than $\pm 0.015\%$ of reading $\pm 0.03\%$ of full scale.
7. Adjust the power supply to obtain 1.0 volt output.
8. Adjust the voltage divider to a selected voltage ratio.
9. Note that the reading obtained on the instrument does not vary from the ratio selected by more than $\pm 0.05\%$ of reading $\pm 0.01\%$ of full scale.
10. Remove the connection between voltage divider HI and DC power supply +, and connect between voltage divider HI and DC power supply -.
11. Repeat paragraphs 1 through 9 for a minus ratio.

RESPONSE TIME

To accurately measure the step response time of the instrument the following test equipment is required:

1. Precision, stable DC power supply.
2. Dual beam oscilloscope with 200 micro-volt sensitivity.

Connect the equipment as shown in figure 4-5. The oscilloscope connections are as follows:

CHANNEL A INPUT	TP13
SIGNAL COMMON	COMMON
EXTERNAL TRIGGER	TP14

To review the necessary waveform position the oscilloscope controls as follows:

1. Set up oscilloscope for single sweep operation with a sweep time of 0.1 second per centimeter.
2. Adjust the oscilloscope sensitivity to 1 volt per centimeter.

Step response time is specified as a maximum of 750 milliseconds with an average of 330 milliseconds. It can be considered as the time for the instrument to reach a null from a previous reading without a range or polarity change. This measurement is accomplished as follows:

1. Adjust the DC power supply to any voltage less than 10.0 volts.
2. Allow the instrument to null.

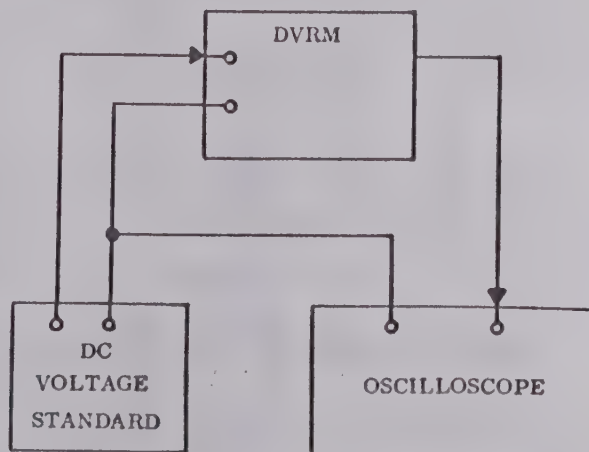


Figure 4-5. Response Time Setup.

3. Position the POWER switch to STANDBY.

4. Adjust the DC power supply to another voltage less than 10.0 volts, and allow sufficient time for the voltage to become stabilized. A period of five seconds is recommended.

5. Position the POWER switch to FILTER OUT and observe the sweep on the oscilloscope. Error signals will be apparent on the sweep until the meter has nulled. The duration of these error signals corresponds to the step response time of the instrument.

INPUT RESISTANCE

In validating the instrument specifications it is necessary to measure input resistance. This is accomplished by measuring the input current at balance and calculating the resistance.

The following equipment is required to perform the input resistance measurement:

1. Resistor: 10 megohm $\pm 0.25\%$
2. Precision, stable DC power supply.
3. A linear voltage divider.

NOTE

Input shielding may be necessary in a noisy environment. High source impedance necessitates a 1 uf. shunt capacitor to stabilize the instrument readout.

Position the instrument controls as follows:

FUNCTION	DC
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER/FILTER	FILTER IN

Arrange the test equipment as shown in figure 4-2 and perform the following tests:

1. Adjust the power supply to obtain 10.000 volts output.
2. Adjust the voltage divider to 99995.
3. Note the reading displayed on the instrument. Insert the 10 megohm resistor in series with the SIGNAL HI (RED) lead and the voltage divider. A drop of 0.0100 volts across the 10 megohm resistor as indicated by the instrument reading represents a 1000 megohm input resistance at DC. The following computations illustrate the validity of the statement:

$$\text{INPUT CURRENT} = \frac{\Delta E}{10^6}$$

$$\text{INPUT RESISTANCE} = \frac{\text{Instrument Reading}}{\text{Input Current}}$$

AC COMMON MODE REJECTION

The common mode rejection ratio is a measurement of the ability of the instrument to reject an AC signal common to both the signal HI and the signal LO input connection while measuring a low level DC voltage.

The effect of common mode signals on the operation of the instrument is tested by applying a DC voltage

of less than 2.0 volts between the SIGNAL HI (RED) and SIGNAL COMMON (BLACK) inputs to the instrument. A common mode signal (60 cps or 400 cps) is then inserted between Signal Common and chassis ground. This common mode signal is then slowly increased until instability is noted in the least significant decade of the instrument. At this point the error voltage resulting from the common mode signal is approximately 100 microvolts. The common mode rejection capability is then established by determining the ratio of the common mode signal to the resulting error voltage (100 microvolts) and expressing the solution in decibels.

The following test equipment is required to perform the AC common mode rejection measurement:

- 1. Wide band audio oscillator.
- 2. Mercury cell, 1.34 volts.
- 3. RMS voltmeter capable of measuring the amplitude of the common mode signal.
- 4. Resistors: 1K 1/2W±5%; 10K 1/2W±5%; 100Ω 1/2W ±5%.

Position the instrument controls as follows:

FUNCTION	DC
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER FILTER	FILTER IN

Prior to determining the AC common mode rejection ratio, measure the resistance between the signal common and chassis. The ohmmeter used should indicate a resistance of greater than 1000 megohms.

Arrange the test equipment as shown in figure 4-6 and perform the following steps:

- 1. With no AC voltage supplied, allow the instrument to null and observe the reading.
- 2. Insert in series with the SIGNAL HI (RED) lead and the SIGNAL LOW (BLACK) lead, the value of resistor applicable to the specific portion of the common mode measurement being made.
- 3. Adjust the oscillator frequency to either 60 or 400 cycles.
- 4. Slowly increase the output of the oscillator until an instability occurs in the least significant decade on the instrument.

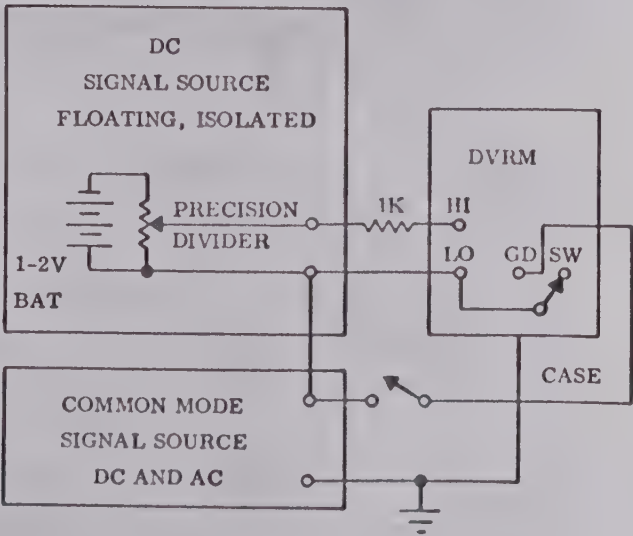


Figure 4-6. Common Mode Interference Ratio Test Setup.

5. Vary the voltage divider setting slightly to stabilize the instrument.
6. Again increase the output of the oscillator until instability occurs.
7. Measure the peak AC voltage at the output of the audio oscillator.
8. Calculate the common mode rejection ratio as shown below.

EM = Amplitude of common mode signal

ED = Amplitude of error signal resulting

CMR = Common mode rejection ratio

$$CMR = 20 \log \frac{EM}{ED}$$

NOTE

When the guard of the instrument is to be driven from an external source the switch at the rear of the instrument must be positioned for floating operation. Under these conditions the guard input must be applied to Pin 7 of the front panel signal input connector J-1F, Pin 7 of the rear panel signal input connector J-1R or Pin 19 of connector J3 on the rear panel of the instrument.

CAUTION

Where the guard shield is driven from the common mode voltage source the voltage between the guard shield and the signal LO must be limited to 50V DC or peak AC. This voltage will be that developed across the unbalanced resistor in series with the low input of the instrument. Maximum common mode voltage is limited to 500 V DC or RMS AC.

The DC rejection characteristics of the instrument indicate its ability to measure low amplitude voltages accurately when the desired signal is floating on a large DC potential. The amount of DC which can be rejected is chosen as that voltage which, when impressed between signal LO and chassis ground, will cause a change in the least significant decade of the instrument. The procedure to be followed when validating this portion of the specification is identical with the procedure for AC common mode rejection ratios, except that a DC power supply is substituted for the audio oscillator. The rejection ratio is calculated, using the same formula as is used for the AC rejection ratio.

NORMAL MODE REJECTION RATIOS

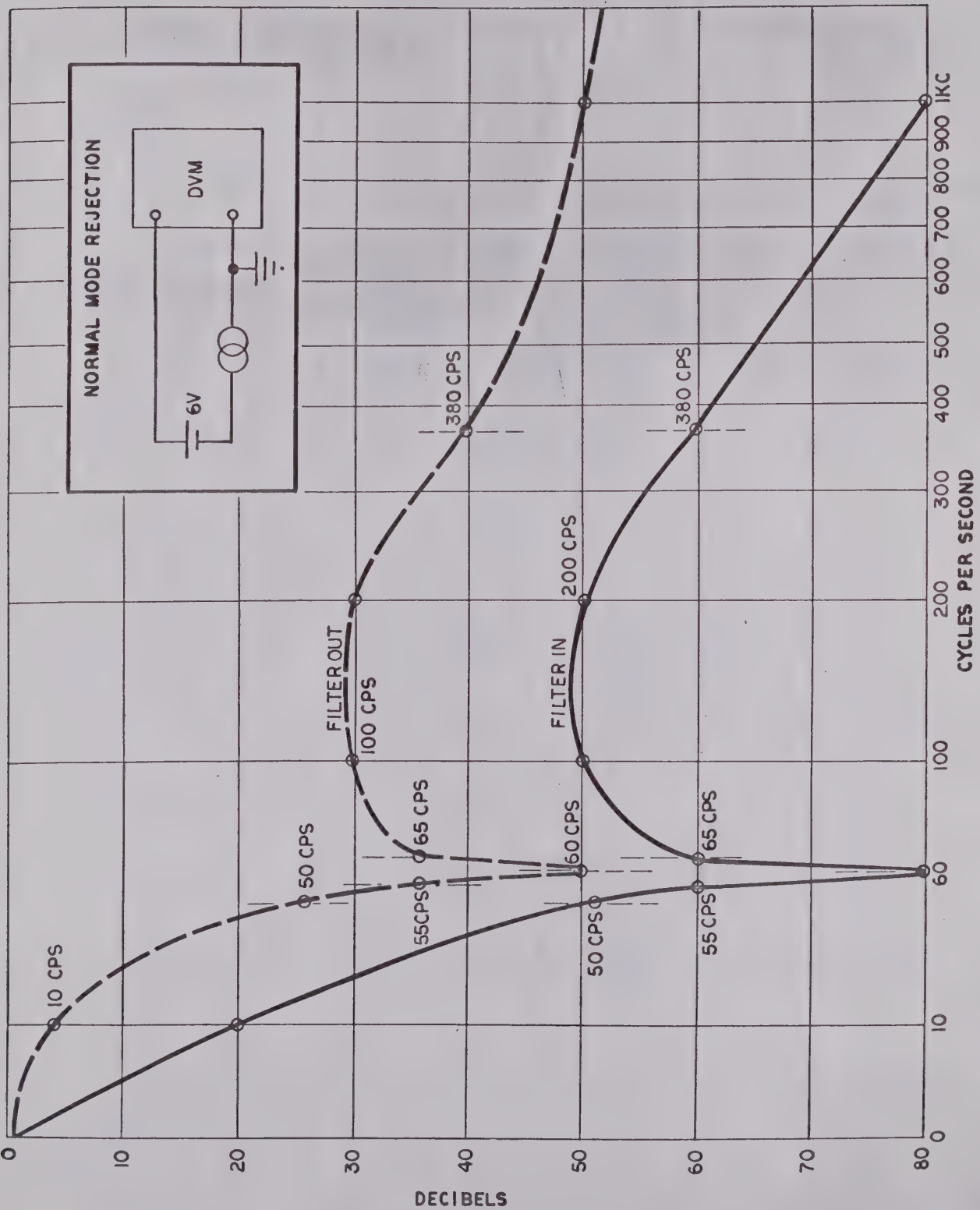
Normal mode rejection is the ability to reject an AC signal superimposed on the signal HI input in respect to the signal LO input.

The following equipment is required to perform the normal mode interference ratio measurement:

1. Wide band audio oscillator.
2. Mercury cell, 1.34 volts.
3. RMS voltmeter, capable of measuring the amplitude of the common mode signal.
4. A linear voltage divider.

Position the instrument controls as follows:

FUNCTION	DC
RANGE	AUTO
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER/FILTER	FILTER OUT



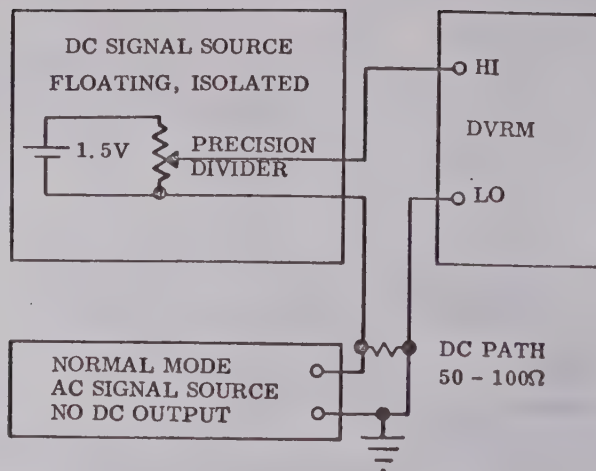


Figure 4-7. Normal Mode Interference Ratio Test Setup

Arrange the test equipment as shown in figure 4-7 and perform the following steps:

1. Adjust the oscillator to produce a 60 cps or a 380 cps signal dependent upon the specification being validated.
2. Position the POWER/FILTER switch on the instrument to either FILTER IN or FILTER OUT dependent upon the specification being validated.
3. With the AC signal at zero and with no DC present at the output of the signal generator, allow the instrument to null and observe the reading obtained.
4. Slowly increase the AC signal output until an instability is detected in the last digit of the instrument.
5. Adjust the voltage divider to cause the instrument to stabilize.

NOTE

If it is not possible to stabilize the instrument with a slight change in the voltage divider setting, the AC normal mode signal may be too high. The desired point of measurement is when the AC signal is of sufficient amplitude to just cause instability in the instrument.

6. Compute the normal mode rejection ratio as follows:

EM = Amplitude of normal mode signal.
 ED = Amplitude of error signal resulting.
 NMR = Normal mode rejection ratio.

$$NMR = 20 \log \frac{EM}{ED}$$

SECTION V

THEORY OF OPERATION

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GENERAL

The 9000 Series Digital Voltmeters and Digital Volt-Ratiometers are essentially closed-loop digital servo systems. The principle of operation is one of voltage comparison. The value of an unknown voltage is determined by comparing it with a known voltage. The known voltage is obtained by dividing a stable, internally-generated reference voltage across a series of fixed resistors (figure 5-1). The value of the unknown voltage is determined by moving the potentiometer arm until the sensing device indicates the value of the voltages to be equal. This is referred to as a condition of "null" or "balance".

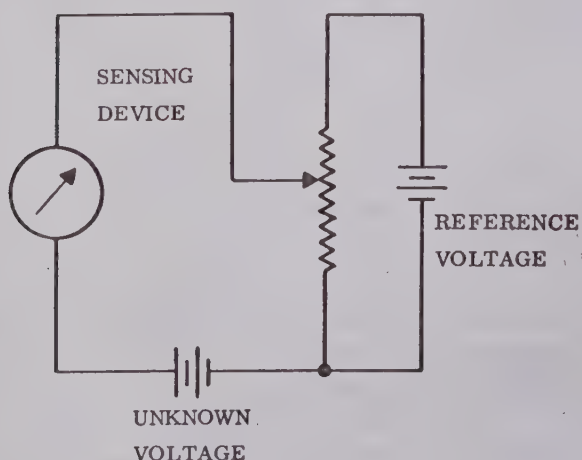


Figure 5-1. Basic Operating Principle of a DVM.

The basic method of comparison is a servo which examines the input voltage and then the known reference voltage. If a voltage difference is detected, the reference voltage is varied until a balance is attained. The input voltage is automatically attenuated as necessary to ensure that its value is less than the reference voltage. In doing this the voltmeter senses as little as 100 microvolt variance between the value of the input and reference voltages.

This requires very stable resistors; components possessing low temperature coefficients; low drift, high gain amplifiers; and the ability to reject unwanted signals such as those caused by ground loops. The ability to ascertain the unknown voltage in a minimum time requires a logic that can approach the final reading in the fastest manner possible. The logic used in the 9000B instruments provides great flexibility and is able to select the shortest of several different routes to achieve balance in exceptionally short time.

The following circuit description traces the input signal through the digital voltmeter, with a detailed analysis of each assembly, including the operation of various logic and counting sequences. A schematic of each assembly is located in Section VI and can be folded out while reading the description in Section V. Both the description and the schematic are in sequential order and have been assigned corresponding numbers.

SIGNAL CIRCUITS BLOCK DIAGRAM (Schematic 1)

Digital Voltmeter input connections are shown on the left hand side of the drawing. Signal inputs are applied to either of the parallel input connectors, J1F and J1R. These two connectors are paralleled inside the instrument so that either input may be used. From the input connector the signal is fed into the input selector. The input selector is controlled by the frontpanel FUNCTION selector and by a diode matrix in the plug-in accessory, if installed. The input selector will automatically direct the input signal (i.e., signal high and signal low) to either the plug-in unit or directly to the attenuator in the digital voltmeter. K12 and K56 feed the signal to the plug-in unit. The output from the plug-in unit is connected through K34 into the attenuator of the digital voltmeter. The attenuator provides three ranges, 10V, 100V, 1000V full scale. The range switches are controlled by the range and polarity board. The range and polarity board in turn is controlled by either the manual front

panel switch or automatically by the logic of the DVM. From the attenuator the signal is directed into the input filter. The filter output signal is directed into a chopper. The chopper is a solid state modulator in a sealed module which contains not only the chopper circuit but also an internal oscillator. The electrical equivalent of the chopper is shown in the block diagram as a mechanical chopper. The chopper is driven directly by the oscillator which also provides a trigger output to a gate generator on the driver board. This trigger output is used in the gate generator to synchronize a demodulator or clamp to the chopped input signal. The chopper continuously compares the input signal with the output of a precision potentiometer. The output of this precision potentiometer is identified as "pot arm". If both the input signal and the output of the precision potentiometer are equal, no error signal between the two can be detected. If there is a difference between the two voltages, an error signal is generated by the chopper and coupled into the amplifier. When an error signal is detected, the digital voltmeter is said to be off balance. If an error cannot be detected the digital voltmeter is at balance.

The amplifier is divided into three sections shown as three individual amplifier assemblies, a preamplifier, an intermediate amplifier, and an output amplifier. The error signal is fed directly from the chopper arm into the preamplifier. The preamplifier provides a gain of approximately 20 db. (For exact calibration see detailed calibration procedures in Section IV.) A clearly identified trim potentiometer provides gain adjustment in the preamplifier. From the preamplifier output the signal is fed into the sensitivity circuit. The sensitivity circuit is shown on the block diagram as a simple potentiometer. From the arm or wiper of the sensitivity circuit, the signal is fed to the intermediate amplifier where it is amplified by approximately 26 db before it is applied to the output amplifier stage. The overall signal gain in the amplifier assembly is approximately 66 db. Also shown in the amplifier block is an amplifier polarity control, composed of transistor switches which receive signals from the range and

polarity board. These switches are controlled by the characteristic of the output amplifier. When the positive switch is on, the amplifier output is inverted. When the negative switch is on, the output is not inverted. This is clearly defined in the amplifier circuit description.

The signal from the output amplifier stage is applied to the clamp. The clamp is driven from the gate generator which is synchronized to the oscillator. The clamp circuit will permit the signal to pass only during a very short (2 milliseconds) period. Since the clamp circuit is synchronized to the chopper, it is a demodulator. From the clamp output, the signal is fed simultaneously into the up and down drivers. One of these drivers responds to a positive signal and the other responds to a negative signal. Whichever driver fires first will cause an interlock to prevent the other driver from firing. This guarantees that there can only be one drive signal at a time, either up, down, or none (balance). The drive signals are directed into the logic of the decade boards. The up drive signal is directed into the unit decade first and the down drive signal is directed into the 10K decade first. The decades have their outputs connected to the precision potentiometer and also to the readout. The digitized servo system (with the logic up and down pulses) commands the decades to move into certain number positions. The decades contain drivers which control the positions of the switches of the potentiometer and the numbers which are displayed in the readout. The precision potentiometer 10K decade input (potentiometer high) is connected to a switch on the function board. This switch has two positions, ratio and DC. It is shown in the DC position. In DC the potentiometer high is connected to the reference assembly. Potentiometer low is always connected to signal low which is also DVM circuit common.

The reference is an ultra stable supply voltage calibrated to provide a precise 10V for the precision potentiometer. The polarity of the reference is controlled from the polarity board and is synchronized

through the logic of the DVM to the input signal polarity. For operation as a ratiometer, the potentiometer high is connected through the switch on the function board to an external input terminal.

The instrument has an inner guard shield which is entirely isolated from power line ground and DVM signal circuits. A switch for the termination of the guard shield, S7, is shown in the left bottom corner of the block diagram. S7 is located on the rear panel and terminates the guard shield to signal low or allows it to be in a floating condition. Provisions are made on the programming connector so that the guard shield may be terminated either by remote contact closure or at the signal source. The detailed information for the different connectors is shown in the master wiring schematic.

LOGIC DESCRIPTION (Schematic 2)

This logic represents an entirely new approach to tracking logic. A number or counting system which prefers the odd numbers and skips the even numbers is used. Since the digital voltmeter has many self-checking features, it is very often possible to make a failure analysis from a misbehavior in the readout. However, to interpret a misbehavior it is absolutely mandatory that the logic and counting sequence is completely understood. To advance the count from 0 to 9 in any decade but the ten thousand, the instrument counts in the sequence: 1, 3, 5, 7, 9. Obviously the logic cannot ignore the even numbers entirely; it simply skips them. At any time, the logic is able to reverse its decision and take one step backwards to the next lower even number. For example, to count to the number 6 from 0, the counting sequence is: 1, 3, 5, 7, and one step backward to 6. If a decade count is the decimal number 2, and is to advance to the number 8, the instrument will advance directly to the next higher odd number. The counting sequence is therefore: 2, 3, 5, 7, 9, and one step back to 8. It is important to remember that the logic counts up by odd numbers in the units, tens, hundreds, and thousands decades. The ten thousands

decade, however, counts in a conventional manner (i.e., 1, 2, 3, 4, 5, etc.).

Each decade logic is divided into two sections. The trinary section deals strictly with odd or even number sets. The hexanary section deals with number pairs: (0+1), (2+3), (4+5), (6+7), (8+9), and 9X. Additional logic states transfer the up and down input pulses to the next higher decade or to the next lower decade. The transfer states are identified as oddX and 9X. The logic transfer states are coupled through diode networks so that the readout will always display the correct number regardless of a transfer state. If the logic has the combination oddX and 9X, the readout will display a 9. The logic symbols used to describe the various conditions are shown in table III.

TABLE III
Logic Symbols.

TRINARY	
OddX	ODD TRANSFER STATE
<u>OddX</u>	NOT ODD TRANSFER STATE
Odd	ODD STATE
Even	EVEN STATE
HEXANARY	
(0+1)	ZERO OR ONE
(2+3)	TWO OR THREE
(4+5)	FOUR OR FIVE
(6+7)	SIX OR SEVEN
(8+9)	EIGHT OR NINE
9X	EIGHT OR NINE TRANSFER
<u>9X</u>	NOT EIGHT OR NINE TRANSFER
9X	NINE TRANSFER
<u>9X</u>	NOT NINE TRANSFER

If the decades are in a 00000 count when a series of up drive pulses are received, the following events occur.

NOTE

In the counting logic of the Series 9000B, 0 is treated as an even number.

The first up drive pulse, applied to the units decade, changes the logic from even to odd and advances the count to 1. The second up pulse changes the logic to odd X, and advances the count to 3. The logic cannot return to even until it gets a down drive pulse, so additional up pulses advance the count to 5, 7, 9, and 9X. The change from 9 to 9X is so rapid that the same pulse is transferred to the next higher decade assembly. Further up pulses are also transferred to the next higher decade assembly.

The counting sequence in the tens decade is identical to the counting sequence in the units decade. Once again the logic counts in odd steps starting with even to odd to oddX, continuing up to 9X. The sequence in the hundreds decade and thousands decade is the same. As soon as the thousands decade reaches the 9X state, the up pulse is directed into the ten thousands decade. The up pulses advance the count of the ten thousands decade in the conventional manner: from 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and then to 9X. When the ten thousands decade reaches the 9X state, any additional up pulses applied to the decade are directed by logic to the range and polarity board, where the up pulses fire a one-shot. The one-shot output triggers the range detector and at the same time is applied to a reed switch which, in its closed (auto) state, transfers the one-shot output signal to the range counter to advance the instrument to the next higher range.

Table IV shows the counting sequence for continuous up pulses. The symbol of the dot (.) between the two columns indicates "and".

The trinary determines which of the two numbers in each hexanary number pair is shown on the readout. In the first state shown on the table there is

no drive pulse present. The trinary is in the even state, and the hexanary is in the (0+1) state. The number displayed on the readout is 0. The first up count transfers the trinary state to odd. The hexanary state remains in (0+1). The number displayed on the readout is 1. The next up pulse advances the trinary to oddX, and the hexanary to the (2+3) state. The number displayed on the readout is 3. The trinary remains in the transfer state and the hexanary shifts, in order, to the (4+5) state, the (6+7) state, the (8+9) state and the 9X state. When the decade is in the 9X state the A gate transfers the up output to the next higher decade.

TABLE IV
Up Count.

DRIVE	TRINARY STATE	HEXANARY and STATE	NUMBER DISPLAYED IN READOUT
	Even	(0+1)	0
UP	Odd	(0+1)	1
UP	OddX	(2+3)	3
UP	OddX	(4+5)	5
UP	OddX	(6+7)	7
UP	OddX	(8+9)	9
UP	OddX	9X	9

Up output to next higher decade.

Table V shows the four different states possible in the trinary and hexanary. The four conditions are the only conditions that may exist in the unit.

TABLE V
Four Different Stable States Derived From the Trinary and Hexanary.

TRINARY and HEXANARY

Transfer (X)	.	Transfer (X)
Transfer (X)	.	Not in Transfer ($\bar{X}$)
Not in Transfer ($\bar{X}$)	.	Transfer (X)
Not in Transfer ($\bar{X}$)	.	Not in Transfer ($\bar{X}$)

Down-counting logic on the decades consists of several AND gates and OR gates. The AND gates recognize two simultaneous conditions, and when both conditions exist, produce an output. Down drive pulses, first applied to the ten thousands decade, act upon the most significant decade which is in the transfer state. Down pulses applied to the ten thousands decade are directed simultaneously into AND gates B and E. If the 10K decade is in the 9X state, gate B recognizes the transfer state and the down pulse, and passes the signal through an OR gate to gate F. Gate F recognizes the down signal, and that the 10K decade is not in 0. Gate F output forces the decade to set to 1. If the 10K decade is in a count of any number, but not a transfer state, gate B rejects any down drive input, but gate E accepts the down pulse. The output of gate E is passed to the next lower decade, which is the thousands (1K) decade.

The 1K decade and all the lower decades treat down signals in a different manner than the 10K decade, because the logic is limited to number pairs, and odd-even number sets. A down signal input is directed to gates B and D. If the decade is in the 9X state, gate B passes the down pulse through an OR gate to reset the decade to the number pair (0+1). If the decade is not in the 9X state, the down signal passes through gate D because the input conditions of gate D are satisfied: the decade is not in the 9X state and a down pulse is present. Gate D passes the down signal to gates E and F. If the trinary section is in oddX, the signal passes through gate E to an OR gate. The OR gate forces the trinary section to set to the even stage. If the trinary section is not in oddX, the down signal is rejected by gate E but passed by gate F. The output of gate F is applied to the next lower decade, which is the hundreds decade. The down signals pass through similar logic in the hundreds decade, tens decade, and the units decade until the down pulses finally appear at the output of the F gate of the units decade.

NOTE

Passing the down signal through the decades, starting with the most significant decade first, causes all decades to clear the transfer state. Whenever all transfer states on a decade are cleared, the down signal passes on to the next lower decade. Passing the down signals through the decades in this fashion clears only the transfer states.

The down pulses from gate F of the units decade are connected back into the units decade as reset signals. If the units decade is in the odd logic state, the reset signals pass through the OR gate and force a reset to the even stage. As soon as the decade is in the even stage, the next reset pulse passes through gate G and an OR gate to force a reset to the number pair (0+1). If or as soon as the units decade is in the (0+1) combination, the reset pulses pass through gate C to the next higher decade. The same logical sequence takes place in the tens, hundreds, and thousands decades. When the reset pulses appear at the output of gate C of the 1K decade, they are applied to the 10K decade. On the 10K decade, the reset pulses are directed to an OR gate and gates C and D. If the 10K decade is at any random number the reset pulses pass through the OR gate to gate F. The 10K decade is not at 0, and a reset signal is present, so gate F passes the signal to reset the decade to 1. If or as soon as the decade is in the 1 state, the input conditions of gate D are satisfied and the reset signals pass through gate D to the range and polarity board. On the range and polarity board the reset signals cause the range circuit to reset to the 10V range. If or as soon as the range and polarity board is in the 10V range, or if manual range is selected, the reset signals pass back to the 10K decade, to reset the 10K decade to 0. If or as soon as the 10K decade is in 0 state, the reset pulses pass through gate C to the polarity one-shot on the range and polarity board. When the one-shot fires, the instrument reverses polarity.

Table VI shows the logic states that exist when both the trinary and hexanary are in a transfer state.

TABLE VI

Down Count From Both Transfer States.

DRIVE	TRINARY STATE	HEXANARY STATE	NUMBER DISPLAYED IN READOUT
	OddX .	9X	9
DOWN	OddX .	(0+1)	1
DOWN	Even .	(0+1)	0

The trinary determines that the number displayed by the hexanary is odd. Since the hexanary is displaying 9X, the number displayed is 9. The first down pulse sets the hexanary to the (0+1) state, with the trinary remaining in the oddX state. The number displayed in the readout is 1. The next down drivepulse advances the trinary to even; the hexanary remains in the (0+1) state, and the number displayed in the readout is 0.

Table VII shows a down count when the trinary is in a transfer state.

TABLE VII

Down Count From an Odd Transfer State.

DRIVE	TRINARY STATE	HEXANARY STATE	NUMBER DISPLAYED IN READOUT
	OddX .	(6+7)	7
DOWN	Even .	(6+7)	6
DOWN RESET	Even .	(0+1)	0

TABLE VIII

Down Count From a 9X Transfer State.

DRIVE	TRINARY STATE	HEXANARY STATE	NUMBER DISPLAYED IN READOUT
	Odd .	9X	9
DOWN	Odd .	(0+1)	1
DOWN RESET	Even .	(0+1)	0

TABLE IX

Down Count From No Transfer State.

DRIVE	TRINARY STATE	HEXANARY STATE	NUMBER DISPLAYED IN READOUT
	Odd .	(4+5)	5
DOWN RESET	Even .	(4+5)	4
DOWN RESET	Even .	(0+1)	0

The trinary is in the odd state and the hexanary in the (4+5) state. The number displayed is 5. With neither the trinary nor the hexanary in a transfer state, the next down pulse becomes a down reset which sets the trinary to even; the hexanary remains in the (4+5) state and the number displayed is 4. The next down pulse is also a down reset. The trinary remains in even, the hexanary shifts to the (0+1) state, and the number displayed is 0.

Table X shows a counting sequence with a range change and table XI shows a counting sequence with a polarity change.

TABLE X

Typical Counting Sequence Including a Range Change, Starting at +0.0000 and Going to +23.256.

DRIVE	DVM READING	10K	1K		100		10		1		COMMENT
			HEX and TRI		HEX and TRI		HEX and TRI		HEX and TRI		
	+0.0000	0	(0+1)	Even	(0+1)	Even	(0+1)	Even	(0+1)	Even	
UP	+0.0001	"	"	"	"	"	"	"	"	Odd	
UP	+0.0003	"	"	"	"	"	"	"	(2+3)	OddX	
UP	+0.0005	"	"	"	"	"	"	"	(4+5)	"	
UP	+0.0007	"	"	"	"	"	"	"	(6+7)	"	
UP	+0.0009	"	"	"	"	"	"	"	(8+9)	"	
UP	+0.0019	"	"	"	"	"	"	Odd	9X	"	see note 1
UP	+0.0039	"	"	"	"	"	(2+3)	OddX	"	"	
UP	+0.0059	"	"	"	"	"	(4+5)	"	"	"	
UP	+0.0079	"	"	"	"	"	(6+7)	"	"	"	
UP	+0.0099	"	"	"	"	"	(8+9)	"	"	"	
UP	+0.0199	"	"	"	"	Odd	9X	"	"	"	see note 1
UP	+0.0399	"	"	"	(2+3)	OddX	"	"	"	"	
UP	+0.0599	"	"	"	(4+5)	"	"	"	"	"	
UP	+0.0799	"	"	"	(6+7)	"	"	"	"	"	
UP	+0.0999	"	"	"	(8+9)	"	"	"	"	"	
UP	+0.1999	"	"	Odd	9X	"	"	"	"	"	
UP	+0.3999	"	(2+3)	OddX	"	"	"	"	"	"	
UP	+0.5999	"	(4+5)	"	"	"	"	"	"	"	
UP	+0.7999	"	(6+7)	"	"	"	"	"	"	"	
UP	+0.9999	"	(8+9)	"	"	"	"	"	"	"	
UP	+1.9999	1	9X	"	"	"	"	"	"	"	see note 1
UP	+2.9999	2	"	"	"	"	"	"	"	"	
UP	+3.9999	3	"	"	"	"	"	"	"	"	
UP	+4.9999	4	"	"	"	"	"	"	"	"	
UP	+5.9999	5	"	"	"	"	"	"	"	"	
UP	+6.9999	6	"	"	"	"	"	"	"	"	
UP	+7.9999	7	"	"	"	"	"	"	9X	"	
UP	+8.9999	8	"	"	"	"	"	"	"	"	
UP	+9.9999	9	"	"	"	"	"	"	"	"	
UP	+99.999	9X	"	"	"	"	"	"	"	"	see note 2
DWN	+19.999	1	"	"	"	"	"	"	"	"	see note 3
UP	+29.999	2	"	"	"	"	"	"	"	"	
DWN	+21.999	"	(0+1)	"	"	"	"	"	"	"	
UP	+23.999	"	(2+3)	"	"	"	"	"	"	"	
DWN	+22.999	"	(2+3)	Even	"	"	"	"	"	"	see note 4
UP	+23.999	"	"	Odd	"	"	"	"	"	"	
DWN	+23.199	"	"	"	(0+1)	"	"	"	"	"	
UP	+23.399	"	"	"	(2+3)	"	"	"	"	"	
DWN	+23.299	"	"	"	"	Even	"	"	"	"	
DWN	+23.219	"	"	"	"	"	(0+1)	"	"	"	
UP	+23.239	"	"	"	"	"	(2+3)	"	"	"	
UP	+23.259	"	"	"	"	"	(4+5)	"	"	"	
DWN	+23.249	"	"	"	"	"	"	Even	"	"	
UP	+23.259	"	"	"	"	"	"	Odd	"	"	see note 4
DWN	+23.251	"	"	"	"	"	"	"	(0+1)	"	
UP	+23.253	"	"	"	"	"	"	"	(2+3)	"	
UP	+23.255	"	"	"	"	"	"	"	(4+5)	"	
UP	+23.257	"	"	"	"	"	"	"	(6+7)	"	
DWN	+23.256	"	"	"	"	"	"	"	"	Even	

NOTE 1. When the hexanary goes into the 9X state, it transfers the up drive pulse to the next higher decade.

NOTE 2. When all the decade states are in the 9X state and the logic receives another up pulse, the DVM will shift to the next higher range if the unit is in auto-range.

NOTE 3. When a down drive pulse is received in the 10K decade, and the 10K decade is in a 9X state, the input conditions set the decade to 1 with one down drive pulse.

NOTE 4. Although the decade was in the number wanted, it must clear the transfer state before down pulses can enter the next lower decade. To do this, the trinary advances from oddX to even to odd. This permits the down pulse to enter the next lower decade.

TABLE XI

Typical Logic Counting Sequence Including a Polarity Change, Starting at +8.9999 and Going to -8.0000.

DRIVE	DVM READING	10K	1K		100		10		1		COMMENT
			HEX and TRI		HEX and TRI		HEX and TRI		HEX and TRI		
	+8.9999	8	9X	OddX	9X	OddX	9X	OddX	9X	OddX	
DWN	+8.1999	"	(0+1)	"	"	"	"	"	"	"	ref table VI
DWN	+8.0999	"	"	Even	"	"	"	"	"	"	ref table VII
DWN	+8.0199	"	"	"	(0+1)	"	"	"	"	"	
DWN	+8.0099	"	"	"	"	Even	"	"	"	"	
DWN	+8.0019	"	"	"	"	"	(0+1)	"	"	"	
DWN	+8.0009	"	"	"	"	"	"	Even	"	"	
DWN	+8.0001	"	"	"	"	"	"	"	(0+1)	"	
DWN	+8.0000	"	"	"	"	"	"	"	"	Even	see note 1
DWN RST	+1.0000	1	"	"	"	"	"	"	"	"	
DWN RST	+0.0000	0	"	"	"	"	"	"	"	"	
DWN RST	-0.0000	"	"	"	"	"	"	"	"	"	
UP	-0.0001	"	"	"	"	"	"	"	"	Odd	
UP	-0.0003	"	"	"	"	"	"	"	(2+3)	OddX	
UP	-0.0005	"	"	"	"	"	"	"	(4+5)	"	
UP	-0.0007	"	"	"	"	"	"	"	(6+7)	"	
UP	-0.0009	"	"	"	"	"	"	"	(8+9)	"	
UP	-0.0019	"	"	"	"	"	"	Odd	9X	"	see note 2
UP	-0.0199	"	"	"	"	Odd	9X	OddX	"	"	see note 2
UP	-0.1999	"	"	Odd	9X	OddX	"	"	"	"	
UP	-1.9999	1	9X	OddX	"	"	"	"	"	"	
UP	-2.9999	2	"	"	"	"	"	"	"	"	
UP	-3.9999	3	"	"	"	"	"	"	"	"	
UP	-4.9999	4	"	"	"	"	"	"	"	"	
UP	-5.9999	5	"	"	"	"	"	"	"	"	
UP	-6.9999	6	"	"	"	"	"	"	"	"	
UP	-7.9999	7	"	"	"	"	"	"	"	"	
UP	-8.9999	8	"	"	"	"	"	"	"	"	
DWN	-8.1999	"	(0+1)	"	"	"	"	"	"	"	
DWN	-8.0999	"	"	Even	"	"	"	"	"	"	
DWN	-8.0199	"	"	"	(0+1)	"	"	"	"	"	
DWN	-8.0099	"	"	"	"	Even	"	"	"	"	
DWN	-8.0019	"	"	"	"	"	(0+1)	"	"	"	
DWN	-8.0009	"	"	"	"	"	"	Even	"	"	
DWN	-8.0001	"	"	"	"	"	"	"	(0+1)	"	
DWN	-8.0000	"	"	"	"	"	"	"	"	Even	

NOTE 1. The down pulses have cleared all of the transfer states starting with the most significant decade, which in this case was the 1K decade, and ending with the least significant decade. Since the logic is still receiving down pulses, the DVM readout will start setting to 0, starting with the units decade and continuing to the next higher decade until all the decades are in 0. Since the units, tens, hundreds and thousands decades are already in 0, the pulse will go directly to the 10K decade.

NOTE 2. When a decade is on (8+9) and receives another up pulse, two states will change. These are: the hexary in the decade displaying the 9 will change to 9X and the trinary in the next higher decade will step to odd. Thus, in the counting sequence the units will now be 9X and still display a 9 and the tens decade will display a 1. The tens, hundreds, and thousands decades will count and pass on the up pulses in the same manner.

SIGNAL INPUT CONNECTORS (Schematic 3)

The front panel signal input connector J1F, the rear panel signal input connector J1R, the rear panel 4 wire K Ω input J2, a portion of J3 (programming connector), the guard shield terminating switch S7, and portions of J10B and J10A are shown in schematic 3. Signal input high, on pin A of J1F, is connected through a coax in parallel to pin A of J1R. From J1R it is connected through a coax to the input selector; the shield of the coax is used for the signal low connection. Two fuses are provided in the signal low and signal high inputs.

If the DVM is operated as a ratiometer, the external reference is connected to pins D and H of J1F or J1R, and is directed to the function board where a relay provides selection of the external reference. The external reference is connected to the potentiometer high input. (See Signal Circuit Block Diagram.) To reduce the effects of current sampling, a separate connection, pin E of J1F or J1R, is provided for the external reference common (low). The external reference common is internally connected to signal low (DVM common). The input signal is directed to the input selector, where it is switched to the attenuator of the DVM or the input circuit of the plug-in unit. If the plug-in unit is used, the output from the plug-in is returned to the input selector, where it is connected to the attenuator of the DVM. The DVM circuits are completely enclosed in a guard shield which is isolated from signal circuits and power line ground. Under normal conditions, the guard shield is terminated to DVM circuit common through a slide switch on the rear panel (S7). In the TERMINATED position the DVM guard shield is connected to DVM circuit common. If the guard shield is driven from the signal source, the guard shield terminating switch is moved to the FLOATING position.

If the guard shield is not terminated to the DVM common by S7; it must be terminated externally at the signal source (signal low). Two pins in the programming connector J3 (pin 2 and 27) are provided to allow this connection to be programmed.

Rear panel connector J2 is provided for a special input cable for 4 wire K Ω measurements. This cable provides Kelvin clips and is used in connection with Cimron Model 6911B 4 wire ohms converter. Pin numbers 1, 2, 3 and 4 of J2 are connected directly into J10A. J10A is one of the receptacles for the plug-in unit. For extremely low level measurements, the input connection of J2 can be used to bypass the input selector entirely and feed the input signal from J2 into the plug-in unit. For this reason, the plug-in units have the signal input connections paralleled from J10B to J10A. For more detail, the schematics of the various plug-in units should be investigated.

INPUT CABLE ASSEMBLY (Reference figure 5-2)

The digital voltmeter has two input connector receptacles; J1F on the front panel, and J1R on the rear panel. The signal input cable, Cimron Part No. 90-5004-1 or 90-5004-3, plugs into either input connector receptacle. The signal input leads are identified in figure 5-2. Each input lead is terminated with a banana plug connector. Alligator clip adapters are supplied with the cable. The alligator clip adapters are constructed with gold plating for low level measurement applications. The red alligator clip is Cimron Part No. 2-04711-2; the black alligator clip is Cimron Part No. 2-04711-0.

The 5-wire cable, Cimron Part No. 90-5004-3, allows the positive and negative external ratio reference voltages to be connected to front panel signal input connector receptacle J1F or rear panel signal input connector receptacle J1R.

INPUT SELECTOR ASSEMBLY (Schematic 4)

The input selector used in Series 9000B instruments is shown on schematic 4.

Relays K12 and K56 are printed circuit relays. Reed relays K3 and K4 are always operated in parallel and for simplicity are identified as K34. All relays are operated from the +17V supply. Relays are energized by connecting the coil terminal to circuit

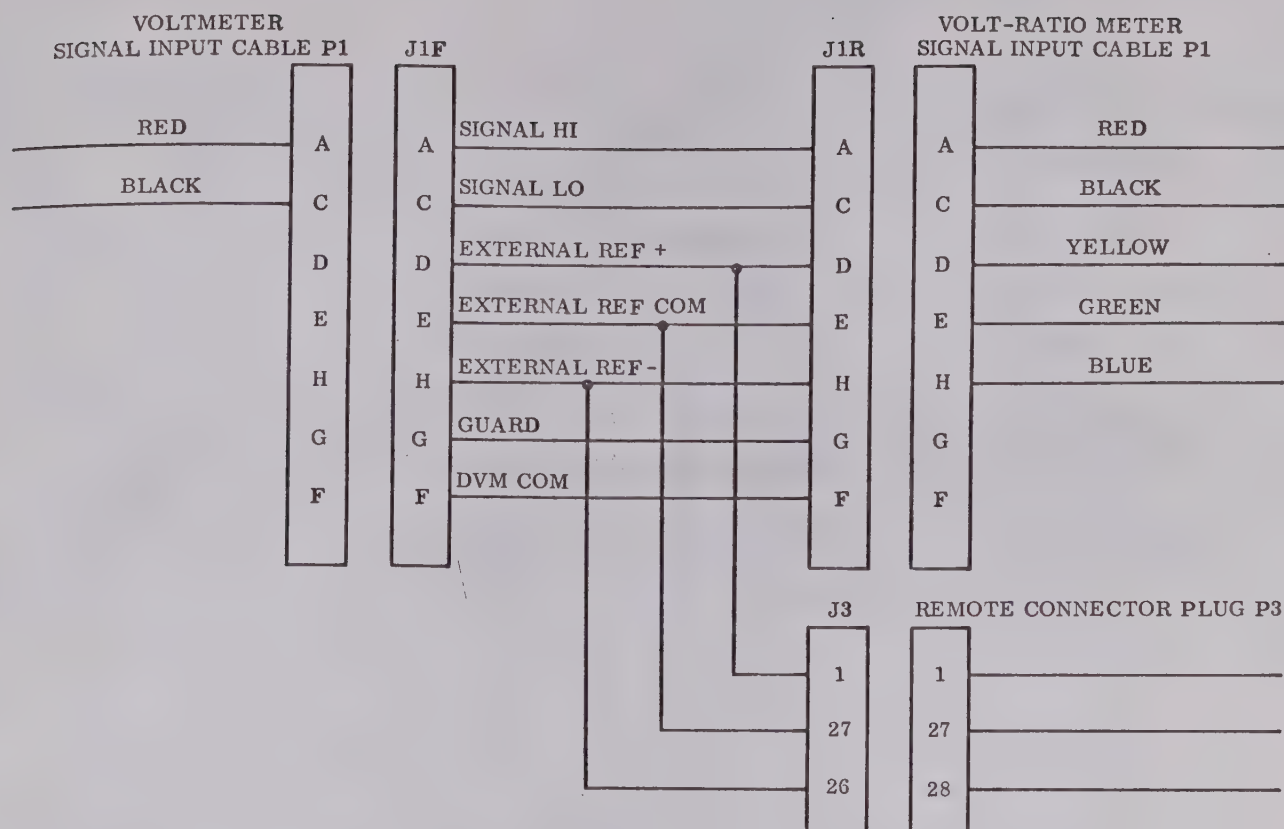


Figure 5-2. Input Cable Assembly.

common through diode networks on the function board or diode networks in the plug-in accessory, if used. The relays are shown in the DC function position; K12 is energized through a diode network on the function board in the DVM.

Input signal high has a fusing jumper provided at the input, for the protection of the internal circuitry against accidental misuse of the instrument. To obtain a low thermal characteristic, the fuse consists of a short piece of single strand 34 gage wire. From the fuse the signal is connected to the arm of K12. In DC function, K12 is energized as shown in the sche-

matic, so that a signal is connected through the closed contacts directly to a terminal, identified as ATH, which is attenuator high in the DVM.

Input signal low is connected through a fuse to the arm of K56. In DC function K56 is not energized. The signal is connected through the normally closed contacts to the terminal ATL which is attenuator low in the DVM.

When the DVM is operated with a plug-in module inserted into the accessory compartment and the proper accessory function is selected on the DVM front panel, the contact closures on the input selector

are commanded by the plug-in assembly. K56 and K34 are energized. The input signal high is connected through the fuse to the arm of K12. K12 is not energized in accessory function, therefore the signal passes through the normally closed contacts to the terminal identified as A1. A1 is the input signal high connection to the plug-in unit. Input signal low is connected through the input fuse to the arm of K56. K56 is energized. The signal is connected through the normally open contacts, which are now closed, to the terminal identified as A14. A14 is the input signal low connection to the plug-in unit. The output high from the plug-in unit comes to terminal B2. From B2 it is connected through closed switch S1, to attenuator high (ATH). The output low from the plug-in unit comes to terminal B14, and is applied to terminal ATL through S2.

The input selector board is mounted underneath a mounting shield in the right rear corner of the DVM directly behind the plug-in accessory compartment. The two input fuses are exposed however, so that in case it should be necessary, the fuse can be replaced without unnecessary disassembly.

ATTENUATOR ASSEMBLY (Schematic 5)

This assembly contains the attenuator, input filter, and chopper network which compares the input signal with the potentiometer output. Ranging is accomplished by reed relays. There are three relays in the attenuator and one additional relay for a filter. The relays are driven from the +17V supply. They are energized by terminating the coil terminal to circuit common through transistor switches on the range and polarity board. The filter relay is operated by contact closure at the filter switch on the front panel.

Signal high and signal low are connected to their respective pins from the input selector. Signal low is terminated to DVM circuit common. Signal high goes directly into the resistive attenuator network. The contact closures for the various ranges are as follows: on the 10V range, switch S101 is closed and switches S102 and S103 are open; on the 100V

range, switches S101 and S102 are open and switch S103 is closed; on the 1000V range, switches S101 and S103 are open while switch S102 is closed. Across the attenuator output are a pair of neons, DS101 and DS102, for over-voltage protection. From that point the signal is fed to a twin T network. This network has a very sharp response at 60 cps. The detail characteristics are shown in figure 4-8. At the twin T output a pair of capacitors, C103 and C104, are connected to the filter switch, S104. The normal mode attenuation in both positions, FILTER IN and FILTER OUT, is shown in figure 4-8. From the filter output the signal is connected into the chopper circuit. The chopper is a solid state modulator which continuously compares the input signal with the output of the precision potentiometer (pot arm). The output of the chopper is connected through C108 to the field effect transistor, Q101. The output is taken from the source of Q101 and applied to the amplifier assembly input. R111, R112, and C105 are a filter network which reduces the effects of high frequency transients. C111 is a 10MF capacitor connected between the guard shield and DVM circuit common. It provides a low AC impedance between guard shield and circuit common if the guard shield is driven from an external source, and if there is a high unbalance in the input low. Under normal operation, this capacitor is short circuited by the input guard terminating switch which is mounted on the rear panel of the DVM.

The chopper, shown in the schematic as a block, is mounted on the attenuator board. It is a complete assembly with an internal oscillator which drives the chopper and provides a trigger pulse output to synchronize the gate generator on the driver board. The chopper operates from the +230V supply. R119 is selected to maintain the frequency of the chopper at approximately 100 Hz.

AMPLIFIER ASSEMBLY (Schematic 6)

The amplifier assembly is separated into three sections, a preamplifier, an intermediate amplifier and an output amplifier. The output of each section is identified by TP2, TP3, and TP4. There is a reg-

ulator which supplies +12V (Q9), a second regulator which supplies +8.2V for the preamplifier (VR3), another regulator which supplies a regulated -12V (Q6), and a -8.2V regulator for the preamplifier (VR2). The input signal is connected from the attenuator output to the input of the amplifier (shown as IN). The signal is capacitor coupled to test point number one (TP1).

From TP1, the signal is applied to a differential amplifier pair, transistors Q1 and Q2. From the collector of Q1 the signal is coupled to the base of an emitter follower, Q3. Zener diode VR1, in the emitter circuit of Q2, adjusts the DC level of the output signal. The preamplifier output at TP2 is taken from the arm of gain potentiometer R9. The gain of the preamplifier, from TP1 to TP2, is approximately 20 db. All voltages shown in this schematic are typical but by no means exact. For example, looking at the collectors of the differential pair Q1 and Q2, both collectors are shown as +5V. However, if one collector should measure +6V and the other collector +4V, no malfunction is indicated. If one collector is saturated (approximately 0V), and the other is cut off (approximately 8V), a malfunction is indicated.

From TP2 the signal is capacitor coupled through capacitor C3 to the sensitivity circuit. On the schematic, the sensitivity circuit is shown as a potentiometer identified as SENSITIVITY CIRCUIT.

From the arm of the sensitivity potentiometer the signal is connected to the intermediate amplifier consisting of a differential amplifier pair, transistors Q4 and Q5, an emitter follower, Q7, and an amplifier, Q8. From the collector of Q8, feedback is taken through R14 and C6 to the base of Q4. The frequency response is shaped by the RC network R12, R13, R14, C5, and C6. The frequency response is peaked at approximately 120 cps. The net gain of the intermediate amplifier, TP2 to TP3, is approximately 26 db.

From TP3 the signal is capacitor coupled through capacitor C9 to the output amplifier, which consists of a differential pair, Q11 and Q12, and emitter fol-

lower Q14. Test Point 4 (TP4) is in the emitter circuit of Q14. The gain between test points TP3 and TP4 is approximately 20 db. Two transistor switches, Q10 and Q13, are included in the output amplifier circuit for polarity switching. The bases of Q10 and Q13 are held at circuit common through resistors R26 and R38. The emitters of Q10 and Q13 are also at circuit common holding the switches back-biased.

For negative polarity a +16V control voltage from the range and polarity assembly is applied to the base of Q10 through the pin marked - (minus), and resistor R27. The +16V overcomes the reverse bias on Q10 and the transistor saturates, providing AC circuit common through R31 to the base of Q11. Signal flow for negative polarity, therefore, is from TP3 through C9 and R30 to the base of Q12. From the collector of Q12 the signal is connected to the output emitter follower Q14. The output characteristic of the amplifier is non-inverting. (TP1 to TP4.)

For positive polarity a +16V control voltage from the range and polarity assembly is applied to the base of Q13 through the pin marked + (plus), and resistor R39. The +16V overcomes the reverse bias on Q13 and the transistor saturates, providing AC circuit common to the base of Q12. Signal flow for positive polarity, therefore, is from TP3 through C9 and R29 to the base of Q11. The signal is emitter coupled to Q12 which now has a grounded base. From the collector of Q12 the signal is connected to the output emitter follower Q14. The output characteristic of the amplifier is inverting.

DRIVER ASSEMBLY (Schematic 7)

The driver assembly provides the up and down drive pulses for decade switching. The schematic of the driver assembly is divided into blocks identified as auto gain circuit, amplifier, clamp, gate generator, down driver, and up driver.

Noise pickup is greater at the middle of a potentiometer than at either end and greater for AC voltage measurement than for DC voltage measurement.

Therefore, the auto gain circuit reduces the sensitivity at either end of the reference potentiometer and for AC measurement mode. Control voltages are received from the 10K decade assembly decimal outputs and from the FUNCTION switch, positions AC and AC RATIO.

When the FUNCTION switch is not positioned to AC or AC RATIO and the 10K decade decimal output is 0, capacitor C1, resistor R6, and resistor R80 are in series between the signal voltage and circuit common. Diodes CR1 through CR11 are back-biased. When the 10K decade decimal output changes to 1, CR3 becomes forward-biased forcing Q2 into conduction. Q2 places R10 in parallel with R6. A decimal output of 2 or 3 cuts off Q2 and forces Q3 into conduction. Q3 places R14 in parallel with R6. Q4 places R18 in parallel with R6, and Q5 places R22 in parallel with R6.

When the FUNCTION switch is positioned to AC or AC RATIO, diode CR1 or CR2 is forward-biased forcing Q1 into conduction. Q1 places R3 in parallel with R6 and R80. The reduction in instrument sensitivity is necessary to compensate for the noise and instability usually present in any AC signal.

The attenuated signal from the auto gain circuit is applied to the base of emitter follower transistor Q6 in the amplifier circuit. Test point 12 (TP12) is in the emitter circuit of Q6. The output of the emitter follower is applied to the bases of transistors Q7 and Q8. Diodes CR12 and CR13 provide signal limiting to prevent large error signals from exceeding the dynamic range of the amplifier. Transistors Q7 and Q8 form a differential amplifier. The amplifier output is passed through complementary emitter follower transistors Q9 and Q10. The output of the emitter follower is applied to test point 13 (TP13) in the clamp circuit. The gain between TP12 and TP13 is approximately 20 db.

Clamp transistor Q11 is driven by the gate generator to demodulate the amplifier output. Biased at saturation by resistor R35, the transistor applies

circuit common potential at TP13, completely masking the amplifier output. Positive pulses from the gate generator turn transistor Q11 off during the gate period, permitting the amplifier output to reach the driver circuits.

The gate generator consists of a monostable multivibrator (transistors Q16 and Q17), transistor switch Q18, and output transistor Q19. In the stable state, Q16 conducts, Q17 is cut off. A positive pulse from the chopper oscillator, applied at the junction of resistor R56 and diode CR17, triggers Q17 into conduction. Q16 is cut off. The positive signal from the collector of Q16 is applied to the base of transistor Q18 through a delay network of resistors R55 and R60, and capacitor C12. Q18 is normally off. The signal, delayed by approximately 250 microseconds, triggers Q18 into conduction. Transistor Q19, also normally cut off, is drawn into conduction by the collector of Q18. A positive gate pulse of approximately two milliseconds duration is produced at the collector of Q19. The gate pulse is applied to the clamp through resistor R65. The junction of resistors R64 and R65 is connected to a pin connector of the driver assembly board. Circuit common, applied to the connector pin through the PRINT CONTROL or POWER switch, disables the gate in HOLD or STANDBY conditions.

The demodulated amplifier output signal at TP13 is direct-coupled in parallel to the up and down driver circuits through resistors R36 and R37. The up driver and down driver circuits are complementary monostable multivibrators. PNP transistors are used in the up driver; NPN transistors are used in the down driver. The down driver output is through a PNP transistor to obtain proper signal inversions. The up driver circuit responds to positive input signals from the clamp circuit. The down driver responds to negative input signals from the clamp circuit. The driver circuits are basically similar; only the up driver is described in detail.

Regulated -12V DC collector supply voltage for the up driver circuit is provided from the -18V DC supply through zener diode VR3 and filtered by re-

sistor R66 and capacitor C13. Transistors Q20 and Q22 form a monostable multivibrator. In the stable state Q20 is saturated and Q22 is cut off. Transistor Q21 provides an interlock from the down driver, conducting only when the down driver is fired. Q20 receives base current through a resistive and zener diode network consisting of resistors R39, R67, R68, BALANCE adjustment potentiometer R38 and zener diode VR2. When the error signal from the clamp circuit exceeds one volt positive, Q20 is cut off, causing Q22 to conduct. The up drive pulse is taken from the collector of Q22 through capacitors C16 and C17 in parallel, and applied to pin connectors identified as UP 1 and UP 2. Test point 15 (TP15) is in the UP 2 circuit. UP 1 output is connected to the digital voltmeter logic. UP 2 output is an input to the null detector in the print control assembly.

Q21 is the interlock transistor in the up driver. Q13 is the interlock transistor in the down driver. Both transistors are biased off. When Q22 of the up driver is conducting, circuit common potential at the transistor collector is applied through resistor R71 to the base of Q13 in the down driver. Q13 conducts, holding the base of transistor Q14 at circuit common potential for as long as Q22 is conducting. The down driver cannot respond to an input signal while the up driver is generating a pulse. Q21 in the up driver is controlled in a similar manner to prevent an up pulse while a down pulse is being generated. DOWN 1 output is connected to the digital voltmeter logic. DOWN 2 output is an input to the null detector in the print control assembly. Both up and down pulses are positive pulses of approximately two milliseconds duration.

The BALANCE adjustment potentiometer R38 balances the bias of both driver circuit input transistors simultaneously to provide equal response. Voltages shown on the schematic refer to normally off, or no-signal, condition.

DECADE (Schematic 8)

Four decade assemblies are used as units, tens, hundreds, and thousands decades. A 10K decade as-

sembly is used in the ten thousand counting circuit. (See paragraph titled 10K DECADE.) The decade counter assemblies control the precision potentiometer switching relays and the readout display indicators.

Each decade assembly consists of a trinary counter, a hexanary counter, logic gate circuits and ten output driver transistors. Silicon controlled switches (SCS) are used in the ring counter stages.

TRINARY DESCRIPTION

The trinary counter is a ring counter with three stable states, even, odd, and odd transfer (oddX). SCS Q5 is on during the even state, Q6 is on during the odd state, and Q7 is on during the oddX state.

In the oddX state the anode gate (3) of Q7 provides circuit common for the emitter of Q1 and the base of Q4. Q4 is off, reverse-biasing Q3. A positive going up pulse applied to the decade assembly at UP IN turns on Q1, which turns on Q2, providing an up pulse for the hexanary.

A positive down pulse (SET EVEN) applied to the trinary in the oddX state at the cathode gate (2) of Q5 turns on Q5. The anode (4) of Q5 reverse-biases CR1. Q7 turns off, reverse-biasing Q1 and turning on Q4. Q4 applies circuit common to the emitter of Q3. The cathode (1) of Q5 turns on Q28 and the trinary is in the even state.

An up pulse applied to the trinary in the even state momentarily turns on Q3 through RC network R2 and C1. The collector of Q3 applies a circuit common pulse to the anode of Q5, turning off Q5 and in turn Q28. C5 discharges, turning on Q6. The cathode of Q6 turns on Q30 and the trinary is in the odd state.

An up pulse applied to the trinary in the odd state turns on Q3 through RC network R2 and C1. The collector of Q3 reverse-biases CR1, turning off Q6. C7 discharges, turning on Q7 and the trinary is in the

oddX state. Q7 turns off Q4 and turns on Q1. The change from odd to oddX is so rapid that Q1 responds to the same up pulse that changes the trinary state, providing an up pulse for the hexanary.

HEXANARY DESCRIPTION

The hexanary counter is a ring counter with six stable states identified as number pairs, (0+1) (zero or one), (2+3), (4+5), (6+7), (8+9), and (8+9)X. SCS Q13 is on during the (0+1) state, Q14 during the (2+3) state, Q15 during the (4+5) state, Q16 during the (6+7) state, Q17 during the (8+9) state and Q18 during the (8+9)X state.

Each SCS controls two driver transistors corresponding to a number pair. Q28 supplies circuit common to the emitter of the even numbers of the number pairs and Q30 supplies circuit common to the emitter of the odd numbers of the number pairs. Q28 is on when the trinary is in the even state and Q30 is on when the trinary is in the odd or oddX states.

When the hexanary is in a $\overline{(8+9)X}$ [not(8+9)X] state, Q12 is on and Q19 is reverse biased. Q12 provides circuit common to the emitter of Q11. An up pulse from the collector of Q2 turns on Q11 through RC network R29 and C9. Q11 provides circuit common to turn off whichever SCS is on. The next higher SCS is turned on by the RC network situated between each SCS.

When the hexanary is in the (8+9)X state, the anode gate of Q18 turns off Q12 and forward-biases Q19. An up pulse from the collector of Q2 turns on Q19, which turns on Q20. Q20 provides an up pulse for the next higher decade assembly.

A SET (0+1) pulse, applied to the hexanary in the (8+9)X state at the cathode gate of Q13, turns on Q13. The anode of Q13 back-biases CR4 turning off Q18 and the hexanary is in the (0+1) state.

LOGIC GATE DESCRIPTION (Schematic 2)

There are eight AND gate circuits on the decade assembly identified as A through H on schematic 2. AND gate A consists of Q19 and Q20 on schematic 9. The two inputs necessary for an output are circuit common at the emitter of Q19 and an up pulse at the base of Q19. Circuit common for the emitter of Q19 is provided by the anode gate of Q18 when the hexanary is in the (8+9)X state. An up pulse for the base of Q19 is provided by the collector of Q2 in gate H when the trinary is in the oddX state. Q19 turns on, which turns on Q20. The output is an up pulse at the collector of Q20 for the next higher decade assembly.

AND gate B consists of Q8. The two inputs necessary for an output are circuit common at the emitter and a down pulse at the base. Circuit common for the emitter is provided by the anode gate of Q18 when the hexanary is in the (8+9)X state. The down pulse is provided by the next higher decade assembly. Q8 turns on. The output is a set (0+1) pulse for the cathode gate of Q13 in the hexanary.

AND gate C consists of Q23 and Q24. The two inputs necessary for an output are circuit common at the bases of both transistors. Q24 is turned on by the anode gate of Q13 when the hexanary is in the (0+1) state. Q23 is turned on by a reset pulse from the collector of Q25 in gate G when the trinary is in the even state. The output is a reset pulse for the next higher decade assembly.

AND gate D consists of Q9 and Q10. The two inputs necessary for an output are circuit common at the emitter of Q9 and a down pulse at the base of Q9. The circuit common for the emitter of Q9 is provided by the collector of Q12 when the hexanary is in a $\overline{(8+9)X}$ state. The down pulse is provided from the next higher decade assembly. Q9 turns on which turns on Q10. The output from the collector of Q10 is a down pulse to the emitters of Q21 and Q22, gates E and F.

AND gate E consists of Q22. The two inputs necessary for an output are a down pulse at the emitter and circuit common at the base. The down pulse is provided by gate D when the hexanary is in a $(8+9)\overline{X}$ state. The circuit common for the base is provided by the anode gate of Q7 when the trinary is in the oddX state. Q22 turns on providing a reset pulse to Q26 which sets the trinary to the even state.

AND gate F consists of Q21. The two inputs necessary for an output are a down pulse at the emitter and circuit common at the base. The down pulse is provided by gate D when the hexanary is in a $(8+9)\overline{X}$ state. The circuit common is provided by the collector of Q4 when the trinary is in the $\overline{\text{oddX}}$ state. The output is a down pulse for the next lower decade assembly. In the units decade the DN OUT and RESET IN pins are connected together.

AND gate G consists of Q25. The two inputs necessary for an output are circuit common at the emitter and a reset pulse at the base. Circuit common for the emitter is provided by the anode gate of Q5 when the trinary is in the even state. The reset pulse is provided by the next lower decade assembly. The output is a set (0+1) pulse through diode CR7 and OR gate CR3 to the cathode gate of Q13.

AND gate H consists of Q1 and Q2. The two inputs necessary for an output are circuit common at the emitter of Q1 and an up pulse at the base of Q1. The circuit common is provided by the anode gate of Q7 when the trinary is in the oddX state. The up pulse is provided by the next lower decade assembly. The output is an up pulse at the collector of Q2 for gate A.

DECADE LOGIC SEQUENCE — UP PULSES

(Schematic 2)

The trinary counter of a decade is in the even state and the hexanary counter is in the (0+1) state when the indicator controlled by the decade is displaying a zero.

An up pulse, applied to the UP IN terminal of the decade assembly, is directed through R1 to the input of gate H and through R2 and C1 to the base of Q3. Gate H is inhibited in the trinary even state, and therefore ignores the input signal. Q3, however, becomes momentarily saturated, advancing the trinary to the odd state. The indicator display changes from 0 to 1.

The next up pulse is applied to the gate H input and also saturates Q3. The trinary advances to the oddX state. Instantaneously, as SCS Q7 is turned on, the voltage at the emitter of Q1 drops to circuit common, enabling gate H. The up pulse, still present at the base of Q1, is passed through gate H and directed to the input of gate A through R58, and to the base of Q11 through R29 and C9. Gate A, inhibited in the hexanary $(8+9)\overline{X}$ state, ignores the input. Q11 becomes momentarily saturated, advancing the hexanary to the (2+3) state. The indicator display changes from 1 to 3. Up pulse time duration is sufficient for the same pulse to advance the trinary to the oddX state and advance the hexanary to the (2+3) state. Successive up pulses pass directly through gate H to advance the hexanary step by step to the (8+9) state.

When the hexanary is in the (8+9) state, the next up pulse advances the hexanary to the $(8+9)\overline{X}$ state. SCS Q18 is turned on, enabling gate A, which passes the same up pulse to the next higher decade. SCS Q18 holds transistor Q11 back-biased through transistor Q12. Additional up pulses passed by gate H are rejected by Q11, but are passed to the next higher decade through gate A. The decade remains stable in the oddX, $(8+9)\overline{X}$ state. The indicator displays a 9.

DECADE LOGIC SEQUENCE — DOWN PULSES

(Schematic 2)

Down pulses at the DOWN IN terminal of the decade assembly are applied to gate B and gate D. If the hexanary is in the $(8+9)\overline{X}$ state, gate B is enabled by the circuit common potential at the emitter of transistor Q8, and gate D is inhibited by a positive poten-

tial at the emitter of transistor Q9. The down pulse is passed through gate B and OR gate CR3 to the cathode gate of SCS Q13. Q13 turns on, setting the hexanary counter to the (0+1) state. Gate B is inhibited in the $(8+9)X$ state and gate D is enabled. The display indicator changes from 9 to 1. The next down pulse is passed through gate D to gates E and F.

If the trinary is in the oddX state gate E is enabled by circuit common at the base of transistor Q22, and gate F inhibited by a positive potential on the base of Q21. A down pulse from gate D is passed through gate E. The positive pulse output of gate E, applied to the base of OR gate transistor Q26, causes the transistor to conduct. Circuit common at the collector of Q26 is differentiated, the negative portion clipped, and the positive portion applied to the cathode gate of SCS Q5. Q5 turns on, setting the trinary to the even state, and turning off SCS Q7. Gate F becomes enabled and gate E becomes inhibited. The display indicator changes from an odd number to the next lower even number.

If the trinary is in the even state gate E is inhibited and gate F is enabled by circuit common at the base of Q21. A down pulse from gate D is passed through gate F to the DOWN OUT terminal of the decade assembly. In the units decade, a down pulse passed through gate F becomes a reset input to the RESET IN terminal of the units decade assembly.

DECADE LOGIC SEQUENCE — RESET

A reset input to the RESET IN terminal of the decade assembly is applied to gate G and OR gate Q26. Circuit common from the collector of Q26 is differentiated, the negative portion clipped, and the positive portion applied to the cathode gate of SCS Q5. Q5 turns on, and turns SCS Q7 off, setting the trinary counter to even. If the trinary is in the even state, or after it has set to even, gate G transfers the reset signal through OR gate CR3 to the cathode gate of SCS Q13. Q13 turns on and turns off any other hexanary state, setting the hexanary to the (0+1) state. The readout indicator displays a zero.

If the hexanary is in the (0+1) state, or after it has been set to (0+1), gate C transfers the reset pulse to the next higher decade. The connection between the anode gate of SCS Q13 and the base of transistor Q24 causes gate C to ignore the reset pulse while the hexanary is changing state. A reset pulse which resets the hexanary counter cannot be transferred through a gate, to prevent one pulse from accomplishing two reset functions simultaneously.

10K DECADE (Schematic 9)

The 10K decade consists of an eleven state silicon controlled switch ring counter, and all necessary control gating. The ring counter provides ten decimal outputs from 0 to 9. The eleventh state is in the 9X state.

UP SIGNAL OPERATION

In the $9\overline{X}$ state transistor Q12 is on, providing circuit common to transistor Q11. An up pulse momentarily saturates Q11, applying a circuit common pulse to the ring counter +8V DC supply line. The silicon controlled switch which is on (for any number 0 through 9) is turned off, passing a positive trigger through the coupling capacitor to the next higher stage, which turns on. If the up pulse causes the 9X stage to be turned on, gate A, which consists of transistors Q8 and Q9, becomes enabled. The same up pulse which causes the ring counter to advance to 9X is passed through gate A as an up range signal to the range and polarity assembly. In the 9X state transistor Q12 is turned off by the anode gate of Q23, and up pulses are passed directly through gate A.

DOWN SIGNAL OPERATION

In the $9\overline{X}$ state transistor Q12 is on, providing circuit common to transistor Q2 of gate E. Transistor Q3, also part of gate E, is biased off by the collector supply of Q2. Down pulses are applied to the bases of Q1 and Q2. Q2 conducts, triggering Q3, which produces a positive pulse of the same duration and amplitude as the input pulse. The down pulse is

transferred directly to the next lower decade. Transistor Q1, gate B, is back-biased by the positive potential at the anode gate of the 9X stage, SCS Q23.

In the 9X state transistor Q12 is off, back-biasing the emitter of transistor Q2 and inhibiting gate E. The anode gate of SCS Q23 applies circuit common to the emitter of transistor Q1 enabling gate B. A down pulse input is rejected by gate E, and passed by gate B. The pulse is passed through OR gate CR2 to trigger the 1 state, SCS Q14. Gate F is CR8 between the 0 state SCS Q13, and the cathode gate of SCS Q14. When SCS Q14 turns on, Q23 is turned off, inhibiting gate B and enabling gate E. Further down pulses are passed through gate E to the next lower decade.

RESET OPERATION

Reset pulses are applied to the base of transistor Q7, which is normally off. Q7 applies pulse to transistor Q5, and through OR gate CR2 to the cathode gate of SCS Q14. If the ring counter is in any stage except 0 or 1, the counter is set to 1. Transistor Q5 applies the reset pulse to gate C, transistor Q4, and to gate D, transistor Q6. If the 1 stage of the counter is on, or when the counter has been set to 1, gate D is enabled. A reset pulse applied to gate D is passed to the range and polarity assembly as a down range pulse. In manual range mode, the reset pulse is returned directly to the set 0 input of the 10K decade. In auto range mode, the output of gate D is used in the range and polarity assembly to set the DVM to the 10 volt range. A following reset pulse, passed through gate D, is returned to the set 0 input. The set 0 input from the range and polarity assembly triggers transistor Q10, which triggers SCS Q13, setting the counter to 0. Gate D is disabled, and gate C (Q4) is enabled. Further reset pulses are passed through gate C to the range and polarity assembly as polarity pulses.

RANGE AND POLARITY ASSEMBLY (Schematic 10)

The range and polarity assembly contains up range, polarity, and down range gating circuits.

UP RANGE CIRCUIT

Transistors Q2 and Q3 form a bistable multivibrator which is triggered by a positive up range pulse input, and reset by unijunction transistor Q1. The circuit operates as a one-shot with a time period which changes to meet requirements of different operating modes of the DVM. In the quiescent state Q2 is conducting and Q3 is cut off. Up range pulse inputs can occur only when all decades are in the (8+9)X state and up pulses are still received in the 10K decade logic. An up range pulse triggers Q3 into conduction. Circuit common from the collector of Q3 cuts Q2 off and holds it off. The bistable remains in this state until reset by Q1. Diode CR6 is forward biased, disabling the down range circuits while Q3 is conducting. The negative-going signal from Q3 immediately steps the range counter to advance the instrument to the next higher range. Collector current of Q3 also energizes coil L1, closing S1 to light the RANGE indicator in the front panel display.

When Q2 is cut off, capacitors C1 and C2 commence to charge toward collector supply potential through resistor R4 and R5. When the capacitor charge reaches the peak voltage of unijunction transistor Q1, the transistor conducts, coupling a positive signal to the base of Q2. The bistable is reset by the positive input to Q2. The time delay allows the attenuator filter to discharge and assume the correct potential. A second up range pulse is effective only after the circuit has returned to the quiescent state. If the additional filter circuit of the attenuator is used, through the FILTER control on the front panel, the FIL IN terminal is at circuit common. Capacitor C3 is then in parallel with C1 and C2. The increased RC time delay allows the additional filter to discharge to the proper potential when range is changed.

When the DVM RANGE switch is in a manually selected range, or in the 1000V range in AUTO range mode, the range counter cannot step to a higher range. The RANGE indicator in the display flashes to indicate an over range condition. Transistor Q4 controls the on-off flashing time of the indicator with a time delay circuit, to allow sufficient on time for

flashing of the indicator to be discernible: when the bistable resets and Q3 turns off, transistor Q4 saturates, disabling the up range input circuit for a period controlled by resistor R12 and capacitor C4.

RANGE COUNTER

The range counter is a three-stage ring counter. Each stage controls one of the three voltage ranges of the DVM. Transistor Q7 is the 10V stage; transistor Q8 is the 100V stage; and transistor Q9 is the 1000V stage. Due to the diodes in the bias circuits, only one stage can conduct at a time. The output of each stage energizes an associated range control relay in the attenuator and decimal point control circuits in the function assembly. Outputs are designated A1, A2, and A3. In manually selected range modes, the RANGE switch forces the range counter stage for the selected range into conduction through inputs M1, M2, or M3. In AUTO range mode, a negative signal from Q3 steps the counter to the next higher stage, until the 1000V stage is conducting. A down pulse input immediately resets the counter to the 10V stage.

When power is first applied to the DVM in AUTO range mode, the range counter is forced to the 10V stage by circuit common applied through the 10K 0 input. The circuit common turns off Q8 and Q9 through diodes CR18 and CR21. The input establishes an initial condition but does not interfere with normal operation.

DOWN RANGE CIRCUIT

The down range signal is a positive pulse from the 10K decade which only occurs when the 10K decade is in 0 or 1 stage, all other decades are in even, 0 stage, and the logic receives down pulses. Transistors Q5 and Q6 form a down range AND gate. When the DVM is not in the 10V range, Q5 is inhibited through the emitter circuit. A down range pulse input is rejected by the down range gate, but is applied to the range counter. The range counter immediately sets to the 10V range by turning on Q7. A second down range pulse is accepted by the down range gate, which is enabled in the 10V range. The down range gate resets the 10K decade to 0 through the collector of Q6.

When the DVM is operated in a manually selected range, the down range circuits are disabled by forward biasing diodes CR10 and CR11 when in the 100 and 1000 range.

POLARITY CIRCUIT

The polarity circuits consist of a bistable multivibrator, transistors Q12 and Q15, which is controlled by a bistable multivibrator operating as a time delay one-shot, similar to the one-shot circuit in the up range circuits. In quiescent state, transistor Q10 is cut off, and Q13 is conducting. A polarity input pulse from the 10K decade occurs only when the 10K decade is in 0 stage and a reset pulse is received in the logic. Q13 is cut off by the negative-going trailing edge of the input pulse. As the collector of Q13 becomes positive, it triggers Q10 into conduction. The negative pulse from Q10 triggers the bistable Q12 and Q15 to change state. The polarity signals to the amplifier and polarity indicators in the display are immediately reversed.

When Q13 is cut off, capacitor C11 commences to charge toward collector supply potential through resistor R51. When the capacitor charge reaches the peak voltage of unijunction transistor Q14, the transistor conducts, applying a positive signal to the base of Q13. Q13 is triggered into conduction, and Q10 is cut off. The polarity circuit cannot respond to additional polarity reset pulses until Q14 has triggered Q13 into conduction. The charge time of the RC network is sufficient to provide proper on-off periods for the display polarity indicators when a series of polarity reset pulses are received.

The polarity circuit output to the positive polarity indicator also energizes the printact polarity relay in the reference assembly. The polarity circuit output to the negative polarity indicator energizes the EXT REF POL printact relay in the function ratio assembly.

REFERENCE (Schematic 11)

The AC input to the reference assembly is applied directly to voltage reference standard module Z1. The output of Z1 is connected to a polarity selecting

relay, K1. The normally closed contacts of K1 are connected for negative reference output. For positive polarity K1 is energized by the range and polarity assembly. Potentiometer R3 provides coarse reference voltage adjustment and potentiometer R4 provides fine reference voltage adjustment. Resistors R1 and R2 are selected at the factory to match the individual voltage reference standard module. R1 and R2 narrow the span of coarse and fine calibration adjustment for greater resolution and easier calibration.

NOTE

If, for any reason, service on the reference assembly appears necessary, return the assembly to the factory for correction. Only the coarse and fine adjustments should be handled during routine maintenance. No other changes or adjustments to the reference should be attempted.

POTENTIOMETER BLOCK DIAGRAM (Schematic 12)

The precision potentiometer consists of 5 potentiometer decades in a Kelvin Varley arrangement. Each potentiometer decade corresponds to a number decade in the DVM readout. The schematic shows each potentiometer decade with switch closures corresponding to a number displayed in the readout. Due to the stringent requirements in the 10K potentiometer, a set of ratio-matched resistors, matched to 0.001%, are used. To assure low contact resistance for each contact closure, two parallel reeds are used. In the lower potentiometer decades the effects of contact resistance become negligible and single contacts are used. The 1K potentiometer consists of eleven 10K, 0.01% resistors, ratio-matched to 0.003%, and shunted by a resistor network consisting of a 24.995K, 0.01% resistor in series with a 20 Ω trim potentiometer. The 20 Ω potentiometer is identified as TRANSFER. The transfer potentiometer is used to ratio match the total impedance of the thousands potentiometer decade to the individual resistors of the 10K potentiometer. Since all resistors in the 10K potentiometer are ratio-matched to each other, the ratio-

match of the 1K potentiometer to the 10K potentiometer is made with any resistor pair in the 10K potentiometer. The ratio-match is checked at major transfers, for example, a transfer from 0.9999 to 1.0000, by observing the error signal with an oscilloscope. If, after the transfer, the DVM is at a true null, the ratio-match is correct. The remaining portion of the potentiometer is a commonly used Kelvin Varley Bridge. The 10K potentiometer is divided into two boards, mounted to each other in a piggy-back fashion, due to the space required for two reeds in parallel for each contact closure.



The wires protruding from each reed in the coil assemblies serve as an extremely low thermal arrangement. Care must be observed when handling this assembly.

10K, 1K, 100, 10 AND UNITS POTENTIOMETER

The potentiometer is a modified Kelvin Varley. In the standard Kelvin Varley Potentiometer, each decade is composed of eleven equal resistors with the exception of the least significant decade which has ten. The only difference in the potentiometer decades is resistor values and the TRANSFER resistor and its adjustment. In a Kelvin Varley arrangement, as used in the 9000B Series, two adjacent resistors in each decade (except the units decade) are shunted by the next lower decade. The shunting decade is arranged to have a total resistance equal to the two resistors being shunted, which reduces the paralleled combination to a value equal to one of the resistors in the more significant decade. The 10K potentiometer, composed of eleven 10K resistors in series, always has an effective resistance of 100K Ω at the end terminals. The resistance of the entire potentiometer is constant, regardless of potentiometer position.

TEN THOUSANDS POTENTIOMETER (Schematic 13)

The 10K potentiometer is the most significant potentiometer. The eleven 10K Ω resistors are

matched to 0.001%. Paralleled reeds are used for switching to reduce effects of contact resistance. The relay coils are energized through isolation diodes CR911 through CR920 by transistor drives located on the decade boards.

An electrostatic shield in each coil is connected to the guard to reduce pickup between adjacent circuits.

THOUSANDS POTENTIOMETER (Schematic 14)

The 1K Potentiometer is composed of eleven $10K\Omega \pm 0.003\%$ resistors in series. In addition it has a resistive shunt in parallel with the eleven divider resistors. The shunt significantly lowers the current in the lower four decades of the potentiometer and is used to reduce effects of contact resistance in the reed relay switches. The shunt consists of R801 and TRANSFER potentiometer R802. R802 provides exact matching of the 1K potentiometer resistance, including the shunt, to equal two of the $10K\Omega$ resistors of the 10K pot. The transfer adjustment setting effects all significant transfers, i.e., 0.9999 to 1.0000; 1.9999 to 2.0000 etc.

HUNDREDS POTENTIOMETER

TENS POTENTIOMETER (Schematic 15 and 16)

The potentiometer assemblies are identical except for the resistor values. The 100 potentiometer uses $2K\Omega$, $\pm 0.025\%$ tolerance resistors and the 10 potentiometer uses 400Ω , $\pm 0.1\%$ resistors.

UNITS POTENTIOMETER (Schematic 17)

The units potentiometer, which has only ten resistors, provides the potentiometer arm output (pot arm) shown as connection B. Each resistor is $82.5\Omega \pm 1.0\%$.

FUNCTION (Schematic 18)

There are two versions of the function assembly. Function Ratio Assembly 90-6074 is used in Models P9300B and P9500B. Function Assembly 90-6116 is used in Models P9200B and P9400B. The only difference between the two assemblies is ratio capability. The description below refers to assembly 90-6074.

For assembly 90-6116, disregard any reference to ratio or external ratio reference voltage.

The function assembly is composed of a number of relays and a diode matrix. On the left side of the schematic three reed relays are shown. Each coil contains two reeds for decimal point control. The coils L1, L2 and L3 are controlled through diodes CR1, CR4 and CR6 from the range and polarity board. The reed switches in the coils are connected as two sets. The first set, S1A, S2A and S3A, are connected to a ratio common line. The second set, S1B, S2B and S3B, are connected to a DC common line. When the voltmeter is operated in the DC mode, circuit common is supplied to the reed switches through diode CR14. The reed relays present a normal decimal point display, indicating a reading in DC volts. When the voltmeter is operated as a ratiometer, circuit common is supplied to the other set of reeds through diode CR12. The decimal point is shifted one place to the left so that the indicated readout is a ratio. D5, D4, D3 and D2 are the connections to the decimal points on the front panel. 1KV, 100V and 10V are the connections for the decimal point drive from the range and polarity board.

Reed relay L4 and S4, identified as POL, supplies +230V to the anode of the polarity indicator. To display polarity in the readout, coil L4 is energized through diodes CR11, CR13 or CR16. Diode CR11 is returned to an input pin identified as POL DR (polarity drive). The plug-in unit commands polarity display through POL DR. +230V comes from the power supply. "Polarity Anode" returns the +230V to the polarity readout indicator if polarity display is desired.

The range relay, composed of L5 and S5, supplies circuit common to the wiper of the RANGE switch. Coil L5 is only energized when the voltmeter is operated in the basic DC function or DC RATIO function, providing a positive interlock between basic voltmeter operation and plug-in operation. When a plug-in unit is used, the RANGE switch is disabled. The plug-in unit forces the digital voltmeter into whatever range is necessary, regardless of the position of the front panel RANGE switch.

Relay K7401, identified as EXT REF POL, is a polarity selector switch for external reference inputs. The relay is a form C relay. In the normally closed (not energized) state, the arm of the relay is connected to the positive external reference input. For negative external reference, K7401 is energized through diode CR38 from the polarity driver on the range and polarity board.

The arm of the external reference selector is connected to one contact of the REF SEL relay K7402, also a form C relay. The arm of K7402 is connected through POT HI terminal to the precision potentiometer. In the normally closed (not energized) position of the reference selector, the POT HI terminal is connected to the internal reference high input REF HI. When the voltmeter is operated as a ratiometer, K7402 is energized through diodes CR26, CR29, CR31, CR32 or CR33, connecting the POT HI terminal to the external reference. In some systems applications, it may be preferred to program the external reference input and signal polarity. In this case, the external reference relay K7401 may be omitted and a jumper installed as shown in the schematic with Note 2.

The input pin identified as DC is circuit common from the front panel FUNCTION switch when DC function is selected. The circuit common energizes the various relays through diodes CR13 and CR15. Diode CR18 energizes the input selector relay K12 on the input selector board. Range Wiper is circuit common return for the wiper of the RANGE switch, which is disabled when the instrument is operated with a plug-in unit. AC is circuit common from the FUNCTION switch when the voltmeter is operated in AC function. It provides circuit common to the plug-in indicator on the front panel through diode CR19. K Ω is circuit common when the front panel FUNCTION switch is in the K Ω position. K12 is a drive connection for the input selector relay K12. AUX is circuit common when AUX is selected on the front panel FUNCTION switch. PLUG-IN IND is circuit common returned to the function indicator in the plug-in unit when a plug-in function is selected, to light the plug-in indicator.

ACR stands for AC ratio. This is circuit common when AC RATIO function is selected on the front panel FUNCTION switch. DCR stands for DC ratio. This input is circuit common when the front panel FUNCTION switch is in DC RATIO position. Diode CR28 and CR34 apply circuit common to the ratio indicator in the front panel function indicator. In any ratio function, diodes CR26, CR29, CR31, CR32, or CR33 energize K7402, which connects the external reference to the POT HI.

+17V is the power supply for the various relays. EXT REF SELECTOR is a control line from the range and polarity board. When negative polarity is involved, this line is circuit common. POT HI is connected to the high terminal of the precision potentiometer, in the 10K potentiometer assembly. REF HI is connected to the output high of the internal 10V reference.

FUNCTION INDICATOR (Schematic 19)

The function indicator is located on the readout panel next to the polarity indicator. It provides four indications of operating mode or condition. These indications are RANGE, DC, RATIO and PLUG-IN. The range indicator lights momentarily when the voltmeter makes a decision to range up into the next higher range. The range indicator light flashes when the voltmeter tries to range into the next higher range, but the up range is inhibited. For example, when the voltmeter is operated on the manual 10V range and an input which exceeds 10V is connected to the DVM signal input, the voltmeter displays 9.9999, the decimal point remains in its fixed position, and the range indicator flashes. The DC indicator lights when the voltmeter is operated in the DC mode. The RATIO indicator lights when the ratio function is selected. In the DC-RATIO function, both indicators, DC and RATIO, light. The PLUG-IN indicator lights when a plug-in function is selected on the DVM FUNCTION selector. For example, with a Model 6700B AC Converter plugged into the DVM and the DVM FUNCTION switch in the AC function, the PLUG-IN indicator lights. The indicators are lit by four neon lamps DS3601 through DS3604. DS3601 is driven

through a reed switch on the range and polarity board. The switch is closed when the up range one-shot fires. DS3602 (ratio indicator) is driven from the diode matrix on the function board. At the junction of DS3602 and R3601 a second terminal is connected. This terminal, identified as $\overline{R}$, is not used. Neon DS3603 is operated through diode CR3601 or CR3602. Both diodes are returned to the FUNCTION switch. CR3601 is at circuit common when the FUNCTION switch is in the DC RATIO position. CR3602 is at circuit common when the FUNCTION switch is at DC. The PLUG-IN indicator is driven through diode CR3603, connected into the diode matrix on the function board.

RANGE DETECTOR (Schematic 20)

The range detector assembly contains down range and up range decision circuits which provide down range and up range commands to plug-in accessories through isolated contact closures. The up range detector also provides overrange signals to the print output circuits.

DOWN RANGE DETECTOR

The down range detector provides an isolated contact closure, S1, through relay K1, as a down range command to auto ranging plug-in accessories used with Series 9000B instruments.

The requirements for down range decisions are different for various plug-in units, and for different functions of multi-function units. Recognizing the 10K decade in the 0 stage as the only requirement for a down range decision causes unstable ranging points and is therefore insufficient. A down range decision by the down range detector occurs only when the 10K decade is in the 0 stage and one of the following conditions exists: the 1K decade is in some number stage other than 9; the 100 decade is in some number stage other than 9; the 10 decade is in some number stage other than 9 and the DVM is not in AC, AC RATIO, AUX, or AUX RATIO.

Transistors Q1, Q2 and Q3 form an OR gate which is connected to the base of Q6 in parallel with transistor Q4. Transistors Q4 and Q5 are a differential pair in which Q4 is normally conducting and Q5 is normally off. Transistor Q6 is forward biased by Q4 or Q1, Q2 and Q3 in series. Forward bias on Q6 holds transistor Q7 back-biased. Switch S1 of reed relay K1 is open. The down range detector reaches a down range decision when

1. circuit common is applied to the base of Q5 by the 10K decade in the Even 0 stage, causing Q5 to conduct and hold Q4 cut off; and
2. one or more of OR gate transistors Q1, Q2, and Q3 are cut off, allowing the base bias potential of Q6 to drop to circuit common.

When the 1K decade is in some number stage other than 9, diode CR5 is back-biased by the display indicator anode voltage. The base of OR gate transistor Q1 becomes positive, holding the transistor cut off. There is no current flow through resistor R8 and the bias on the base of transistor Q6 drops to circuit common.

When the 100 decade is in some number stage other than 9, diode CR6 is back-biased and transistor Q2 is cut off. There is no current flow through resistor R8 and the bias on the base of transistor Q6 drops to circuit common.

When the DVM FUNCTION switch is in MV, MV RATIO, K Ω , or K Ω RATIO position, and the 10 decade is in some number other than 9, diodes CR1, CR2, CR3, CR4 and CR16 are back-biased, and transistor Q3 is cut off. There is no current flow through resistor R8 and the bias on the base of transistor Q6 drops to circuit common. When the DVM FUNCTION switch is in AC, AC RATIO, AUX, or AUX RATIO position, the respective input diode is forward biased and the condition of the 10 decade does not affect the down range detector circuit.

When transistor Q6 is cut off by the 10K 0 input and one or more transistors of the OR gate being cut off, capacitor C1 starts to charge toward collector supply potential through resistor R15. When the charge on the capacitor reaches the zener voltage of diode CR8 (approximately 6.8 volts), which requires a period of two or three seconds, transistor Q7 is triggered into conduction. Relay K1 is energized, closing switch S1. The time delay prevents false down range signals while the DVM is counting. When Q6 is again forward biased, capacitor C1 discharges through the transistor.

UP RANGE DETECTOR

The up range detector provides an isolated contact closure, S2, through relay K2 as an up range command to plug-in accessories used with series 9000B instruments. The up range detector circuit consists of transistors Q8 and Q10, connected as a one-shot, and clamp transistor Q9. Transistor Q10 is normally saturated and Q8 is normally cut off. Transistor Q9 is also normally off.

When the 10K decade passes an up range signal to the range and polarity assembly the signal is also applied to the up range terminal of the range detector assembly. The positive pulse triggers Q8 into conduction. As Q8 conducts, the negative signal from the collector is coupled through diode CR12 and capacitor C3 to back bias diode CR15. Transistor Q10 is forced to cut off. Diode CR12 cannot pass the signal until collector potential of Q8 has fallen below the zener voltage of zener CR14 (approximately 15 volts). The zener diode desensitizes the one-shot against noise transients. Relay K2 in the collector circuit of Q8 is energized when Q8 is on, closing S2. At the same time an overrange signal is applied to the print output circuits. Transistor Q10 stays in the off condition until capacitor C3 has discharged. When Q10 again conducts, Q8 is cut off. A positive signal from the collector of Q8 is applied to the base of clamp transistor Q9, causing the transistor to saturate, and clamping the base of Q8 at circuit common. Q9 remains saturated until capacitor C2 is charged. While

Q9 is saturated, the input circuit is disabled. Continuous up range signals at the input force the up range detector to respond in a periodic on and off sequence. The on period is approximately 50 milliseconds, and the off period is the charge time of C2.

POWER SUPPLY (Schematic 21)

The power transformer is wound with a split primary winding, connected through a slide switch (S8) so that the instrument may be operated from either 230 or 115 volts AC. From the primary winding, leads 2 and 4 provide 115V for the plug-in units. The power transformer, 230/115 volt selector switch S8 and the fuse are mounted on the rear panel. The POWER switch S1 is mounted on the front panel.

Transformer winding 11-12 provides -18V DC through rectifier bridge CR5 - CR8 and filter C2A, R1, C2B. The -18V output is connected to the power supply assembly to provide a convenient test point.

Transformer winding 7 and 8 is connected to a +150V rectifier, consisting of diodes CR9 through CR12, mounted on a rectifier board. The rectified output is connected to section C of triple section electrolytic capacitor C3 on the master board, and to TP10 on the power supply assembly. R4 is a bleeder resistor for discharging the capacitor after power has been turned off.

Transformer winding 5 and 6 is connected to diodes CR13 through CR16 on the rectifier board. The diodes provide a +240V DC signal which is filtered by capacitor 3A (on the master board), and R1701, giving a filtered +230V DC to the third section of C3B (on the master board). Resistors R2 and R3 are bleeder resistors. The +230V DC can be monitored at TP9 on the power supply assembly.

Transformer winding 1, 2, and 3, with shield 4, is connected to the precision reference assembly.

Transformer winding 9-10 supplies the +22V DC rectifier bridge CR1 - CR4. The rectifier output is filtered by electrolytic capacitor C1A and C1B, and applied to the +17V DC regulated supply through TP8 on the power supply assembly. Transistor Q1 is a passing transistor mounted on the frame of the DVM for heat dissipation, which receives the unregulated +22V as collector supply. The emitter is connected to TP7 through parallel resistors R1707 and R1708. From TP7, feedback is taken through zener diode VR1702 to the base of transistor Q1702. The emitter of Q1702 is returned to a regulated +8.2V (zener diode VR1701). All voltages are indicated in the schematic and should be within 10%. Transistor Q1702 acts as an inverting amplifier which holds the base of series regulator Q1701 at 18.2V DC. The collector of Q1701 is returned to the +22V supply through R1705. Capacitors C1705 and C1706 provide filtering. Diodes CR1701 through CR1703 provide short circuit protection. Since there are two emitter base junctions in series, the voltage drop from the emitter of Q1 to the base of Q1701 is approximately 1.2 volts, and the output is 17.5V DC. If the current through the resistor pair (R1707 and R1708) exceeds 1 ampere, a voltage drop develops across the resistors of more than 0.5V. Under this condition (overload), the voltage drop between TP7 and the base of Q1702 exceeds 8.7V. Diodes CR1701 through CR1703 become forward biased and limit the current through the passing transistor to a maximum of 1 amp, which is a safe rating for the transistor. The +17V supply is overload protected for a continuous short circuit. C1709 provides output filtering for the regulated +17V DC.

PRINT CONTROL (Schematic 22)

The print control assembly places a hold on the instrument and issues a print (end-of-conversion) command.

The print control assembly operates in one of three cycles: auto-print, hold-rebalance, or track-print; as selected by the PRINT CONTROL switch, the REBALANCE pushbutton, and external contact closures.

AUTO-PRINT (Figure 5-3)

An auto-print command is received at terminal AUTO from the front panel PRINT CONTROL switch or from rear panel connector J8-12 (schematic 24 or 25). As the instrument tracks the input, drive pulses

are received at terminals UP and DN (schematic 22) from the driver assembly. The driver assembly gate is connected to terminal GATE.

The drive pulses are directed to the NULL DETECTOR. If no drive pulses are present (instrument at null), a dummy drive pulse must be provided through terminal APC and connector J8-5. When the drive pulses cease for a period determined by the PRINT DELAY adjustment (null), the null detector activates the HOLD 1 SHOT. If the input is unstable (instrument cannot null) and a print command is desired, a forced print command must be provided through terminal FP to activate the HOLD 1 SHOT. The forced print command is provided by positioning the PRINT CONTROL switch to PRINT, and back, or by a contact closure through connector J8-14. A forced printout may or may not be valid depending on the null condition of the instrument when the forced print contact closure is made.

The HOLD 1 SHOT, when activated, provides a clamp command to the CLAMP and activates the PRINT 1 SHOT. The CLAMP grounds the driver assembly gate, disabling the counting circuits. The clamp command is maintained until the HOLD 1 SHOT resets. The PRINT 1 SHOT provides a print command through terminal PC to print output assembly A. After a delay determined by the HOLD adjustment, the HOLD 1 SHOT resets releasing the CLAMP and the instrument returns to tracking the input.

The jumper between terminal HLD and the junction of resistors R26 and R27 is normally not installed. If it is desired to activate the CLAMP externally (provide an external hold on the instrument), install the jumper and remove the wire between terminal HLD and the HOLD position of the PRINT CONTROL switch. Terminal HLD is then grounded through connector J8-7.

HOLD-REBALANCE (Figure 5-4)

The print control assembly operates in the hold-rebalance cycle when the PRINT CONTROL switch is positioned to HOLD or REM and terminals AUTO and TRK are not grounded. The print control assembly is controlled by the REBALANCE flip-flop which in the initial reset condition provides a clamp command to the CLAMP. The CLAMP holds the instrument inoperative. Single-print-and-return-to-hold operation is obtained by depressing the REBALANCE pushbutton or by providing the contact closure through rear panel

connector J8-3. The contact closure grounds the RBL terminal causing the REBALANCE flip-flop to provide a release clamp command and a dummy drive pulse. As the instrument tracks the input, drive pulses are directed to the NULL DETECTOR. When the drive pulses cease for the period of the print delay the NULL DETECTOR activates the HOLD 1 SHOT. If the instrument cannot null and a print command is desired, a forced print command must be provided to activate the HOLD 1 SHOT. The HOLD 1 SHOT provides a clamp command and activates the PRINT 1 SHOT. The CLAMP grounds the gate. The PRINT 1 SHOT provides a print command and resets the REBALANCE flip-flop. The REBALANCE flip-flop provides a clamp command to hold the instrument inoperative until the next rebalance command.

TRACK-PRINT (Figure 5-5)

A track command is received at terminal TRK from the front panel PRINT CONTROL switch or from rear panel connector J8-10. The CLAMP is disabled, allowing the instrument to track the input. Forced-print-and-return-to-track operation is obtained by turning the PRINT CONTROL switch to the spring-return PRINT position, or by providing the contact closure through rear panel connector J8-14. The contact closure grounds terminal FP which activates the HOLD 1 SHOT. If diode CR17 is installed, the HOLD 1 SHOT cannot be activated when terminal TRK is grounded.

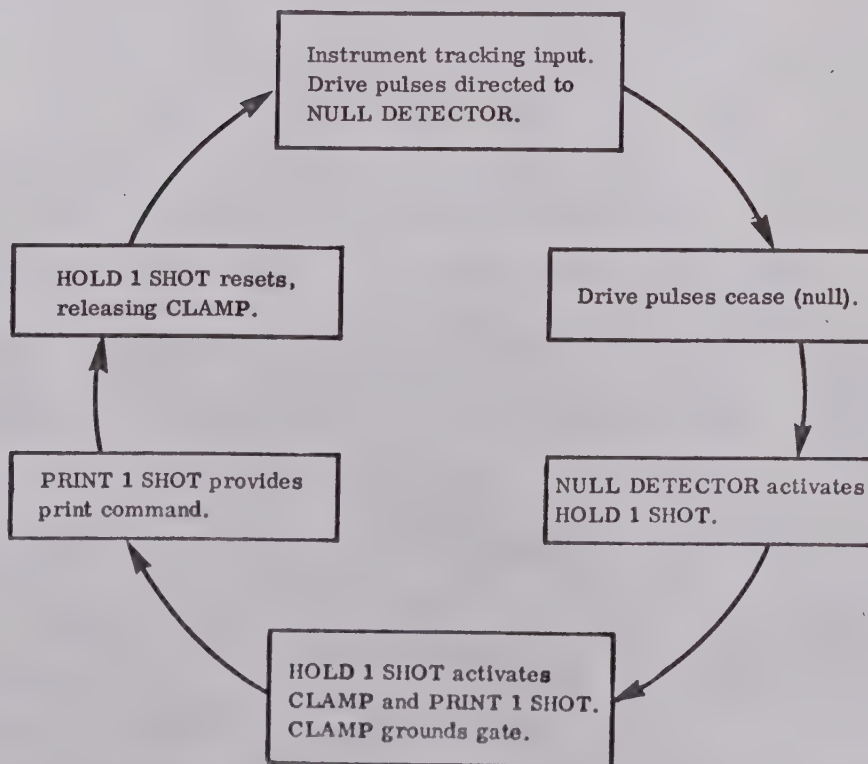


Figure 5-3. Auto-Print Sequence.

The HOLD 1 SHOT, when activated, provides a clamp command and activates the PRINT 1 SHOT. The CLAMP grounds the gate. The PRINT 1 SHOT provides a print command. The forced printout may or may not be valid depending on the null condition of the instrument when the forced print contact closure is made. When the HOLD 1 SHOT resets, the CLAMP is released and the instrument returns to tracking the input.

PRINT OUTPUT (Schematic 23)

The print output circuit provides isolated print output in a 10-line decimal code. The electrical equivalent of the circuit is shown as a simplified schematic. The print output assembly consists of three plug-in boards, print output A, print output B,

and print output C. Print output A has two additional pairs of pins identified as PRI and OR. Print commands from the print control assembly provide isolated contact closures for the print output command which occurs after the DVM has found balance. Overrange is a command from the range detector board. It provides an isolated contact closure output if the DVM is in an overrange condition. Print output B has additional pins, identified as (-) minus and (+) plus, which provide contact closures to indicate polarity.

MASTER WIRING DIAGRAM DESCRIPTION

(Schematics 24, 25, 26, and 27)

This diagram shows the inner connecting wiring between the front panel switches, the readout, the

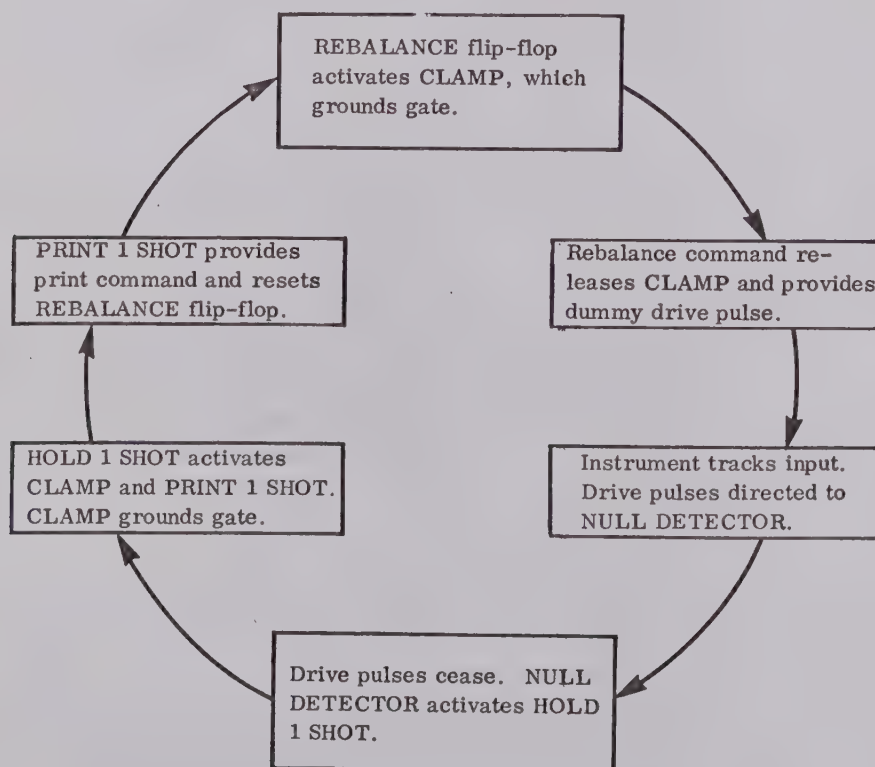


Figure 5-4. Hold-Rebalance Sequence.

master circuit board, the input logic buffer, the signal input connectors, and the interconnections to and from the plug-in unit.

The diagram is divided into 6 sections. The locations on the diagram are as follows:

1. Front panel switches: lower portion of diagram.
2. Connections to the readout and function indicator: above the front panel switches.
3. Bottom view of master circuit board: center of diagram.
4. Input selector: left of master circuit board.
5. Signal input connections and connectors (J10A and J10B) to the plug-in unit: left side of diagram.
6. Logic input buffer: top of diagram.

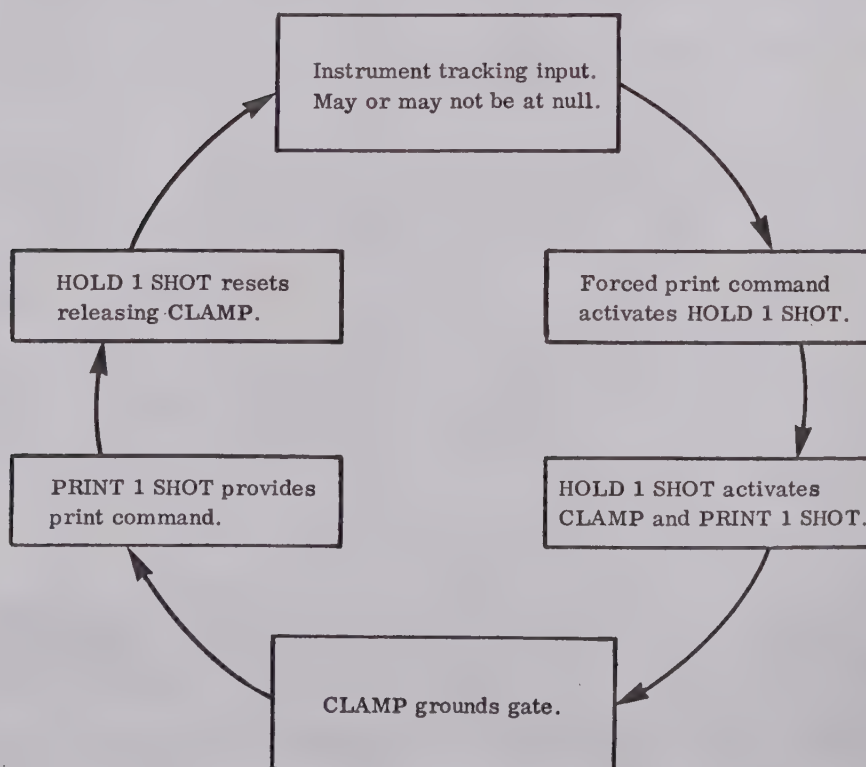


Figure 5-5. Track-Print Sequence.

SECTION VI

MAINTENANCE

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GENERAL

Troubleshooting the instrument is extremely simple. Since the majority of components in the instrument are mounted on plug-in boards, troubleshooting is reduced to systematically replacing existing boards with spare boards until the defect is remedied. Down time is reduced to a very few minutes. Faulty boards can be repaired by the user or returned to CIMRON or a CIMRON representative for

repair. The user of Series 9000B instruments is urged to become thoroughly familiar with the operation of the instrument before any troubleshooting is attempted.

Pages 6-13 through 6-93 contain information on all plug-in boards. Each board is treated separately; a parts list of all replaceable electronic parts, a picture guide for component location and a schematic of each assembly are provided. The information for

each board is contained on consecutive pages. Pages 6-95 through 6-107 contain schematics showing board interconnections.

The slots into which the various boards fit into the instrument are assigned a number. This number is marked on the rail adjacent to the slot. The number also appears on the plug-in board. In replacing boards it is necessary only to match the board number with the number on the rail. This should preclude any possibility of replacing a board in an improper slot once it has been removed.

Since many of the components used in the instrument are standard electronic parts, the user may obtain them locally if desired. However, it is recommended that precision components and mechanical parts be ordered from the CIMRON representative or direct from the factory.

When replacing components on a printed circuit board, care should be taken to prevent damage to the board from excessive heat. A low wattage soldering iron is recommended for soldering operations on the board or when removing or replacing transistors. Whenever practicable, a heat sink should be used between the soldering point and the transistor body.

DISASSEMBLY FOR MAINTENANCE

Disassembly of the voltmeter for maintenance or for troubleshooting is accomplished as follows:

1. **Top Cover.** Remove four oval head countersunk phillips head screws securing the top cover to the instrument and remove the cover. A spring-loaded bullet catch is provided to lift one side of the cover away from the instrument to aid in removal.
2. **Bottom Cover.** Remove four oval head countersunk phillips head screws and remove the bottom cover.

3. **Inner Guard Shields.** There are two guard shields in the unit, upper and lower. The upper guard shield is secured to the instrument by five 4-40 pan head screws. Normal maintenance and adjustment may be accomplished by removing only the upper shield.

4. **Plug-In Board Removal.** If it is necessary to remove a plug-in board for repair or replacement, always use the wire board puller which is located in a mounted bracket under the guard shield. Insert the board puller from the component side of the board and pull straight out.

CAUTION

Power must be off when removing or replacing board assemblies.

5. **Neon Display Tube Removal.** Remove the two allen head screws and one of the polarized retainers. The display polarizer may then be snapped out of the front panel. An octal vacuum tube puller may be used to remove the neon display tube. After the display tube is replaced, insert the polarizer first into the still attached retainer and then spring it into position along the opening in the front panel. When nearly into position, slip on the retainer which was removed, position it in place, and replace the screws.

TROUBLESHOOTING

The voltage measurements and wave shapes necessary to indicate proper operation of a plug-in board are listed on the applicable schematic diagrams. These diagrams are placed in the manual in a logical sequence of trouble isolation. Failure to obtain the required voltages or wave shapes usually will indicate which plug-in board is defective. Its replacement should restore the voltmeter to its normal specified

operation. Replacement of the attenuator, amplifier, logic driver, or reference assemblies will require complete recalibration of the instrument. The procedure for recalibration is outlined in Section IV of this manual.

PRINT CONTROL POTENTIOMETER ADJUSTMENT

The PRINT DELAY adjustment controls the amount of time the NULL DETECTOR waits, after the drive pulses cease, to activate the HOLD 1 SHOT. The delay is adjustable from 100 to 200 milliseconds.

The HOLD adjustment controls the amount of time the HOLD 1 SHOT provides the clamp command. The required time depends on the speed of the printer or recording device.

The following equipment is required to perform the print control adjustments:

1. Oscilloscope, Tektronix Model 502 or equivalent
2. Extender Assembly, Cimron Part No. 80-9501-1

Perform the print control adjustments as follows:

1. Position the front panel controls as follows:

FUNCTION	DC
RANGE	10
PRINT CONTROL	AUTO PRINT
SENSITIVITY	HI
POWER	FILTER OUT

2. Extract the print control assembly from the instrument, replace it with the ex-

tender assembly, and mount the print control assembly on the extender assembly.

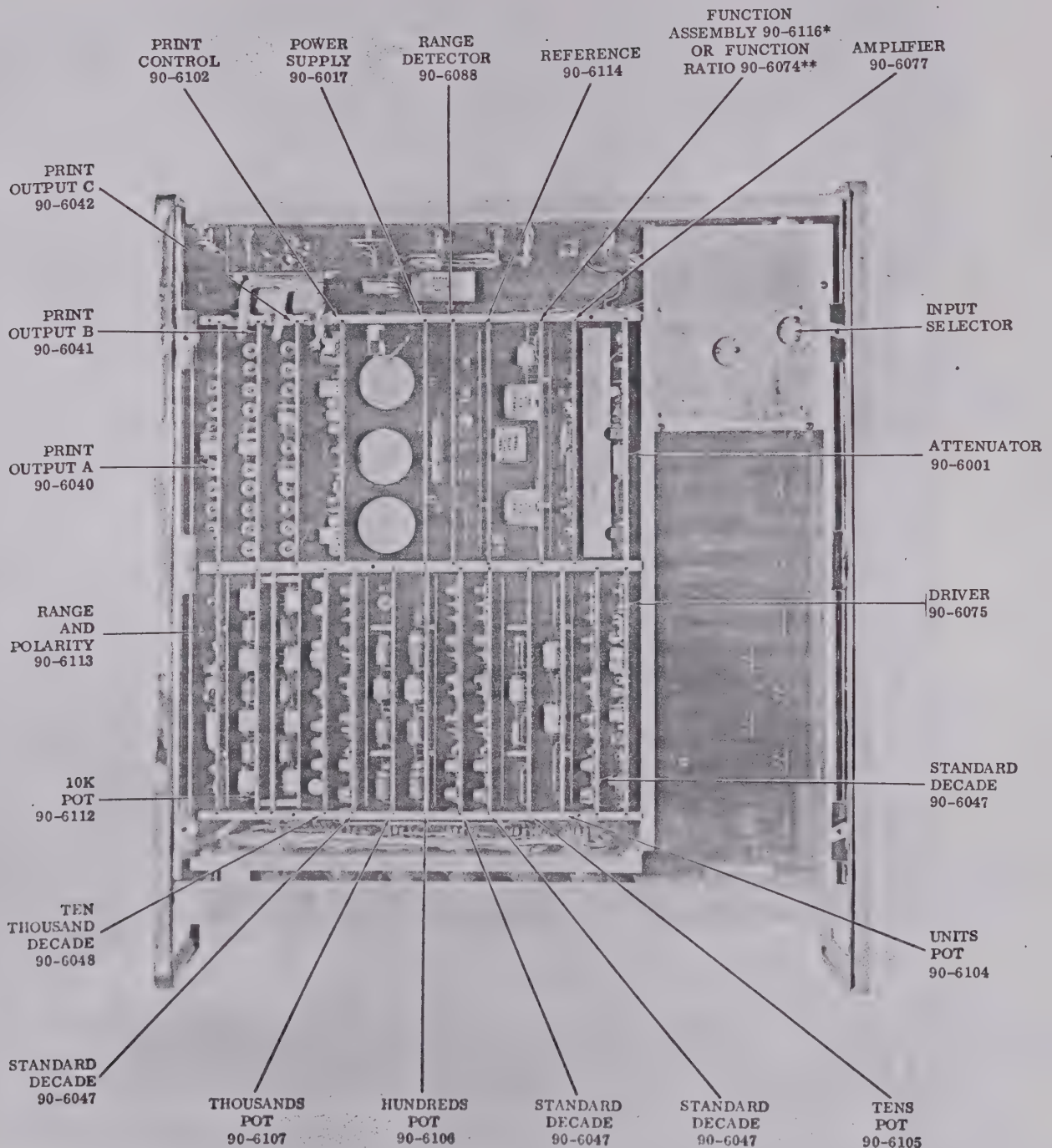
3. Position the oscilloscope front panel controls for external negative DC trigger, 100 ms/cm time, 5V/cm sensitivity (X1 probe).
4. Short the signal input leads and allow the instrument to balance at zero.
5. Connect the oscilloscope trigger input to the case (collector) of Q5 (figure 6-20) on the print control assembly.

PRINT DELAY

1. Hold the oscilloscope probe against the case of Q5.
2. Press the REBALANCE switch and observe the pulse on the oscilloscope.
3. Vary R14 (figure 6-20) for a pulse duration greater than the period or change of the slowest changing voltage to be measured by the instrument.

HOLD

1. Hold the oscilloscope probe against the case (collector) of Q8 on the print control assembly.
2. Press the REBALANCE switch and observe the pulse on the oscilloscope.
3. Vary R37 (figure 6-20) for a pulse duration greater than the cycle of operation of the printer or recording device employed.



*P9200B AND P9400B ONLY
**P9300B AND P9500B ONLY

Figure 6-1. Assembly Locations.

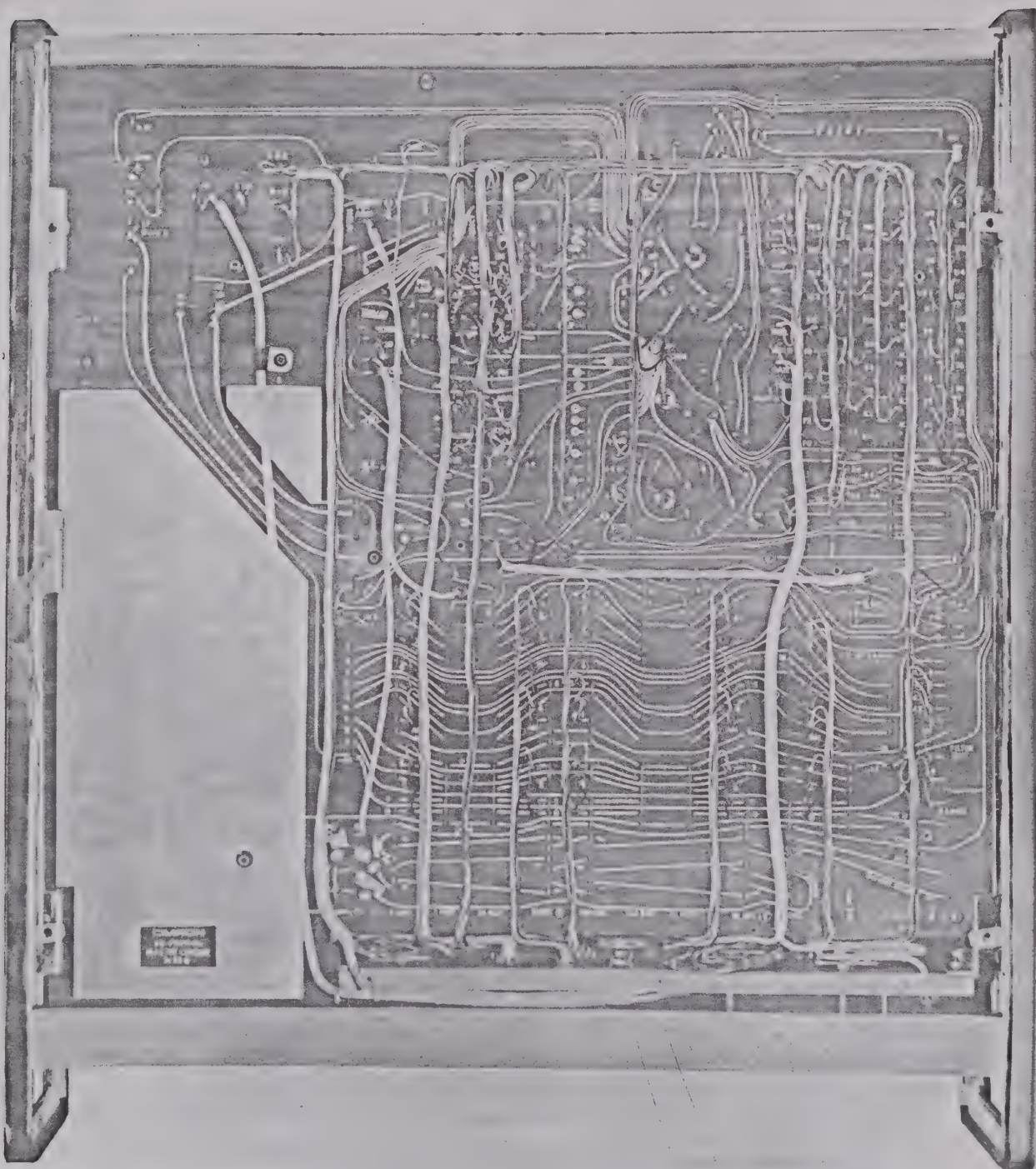
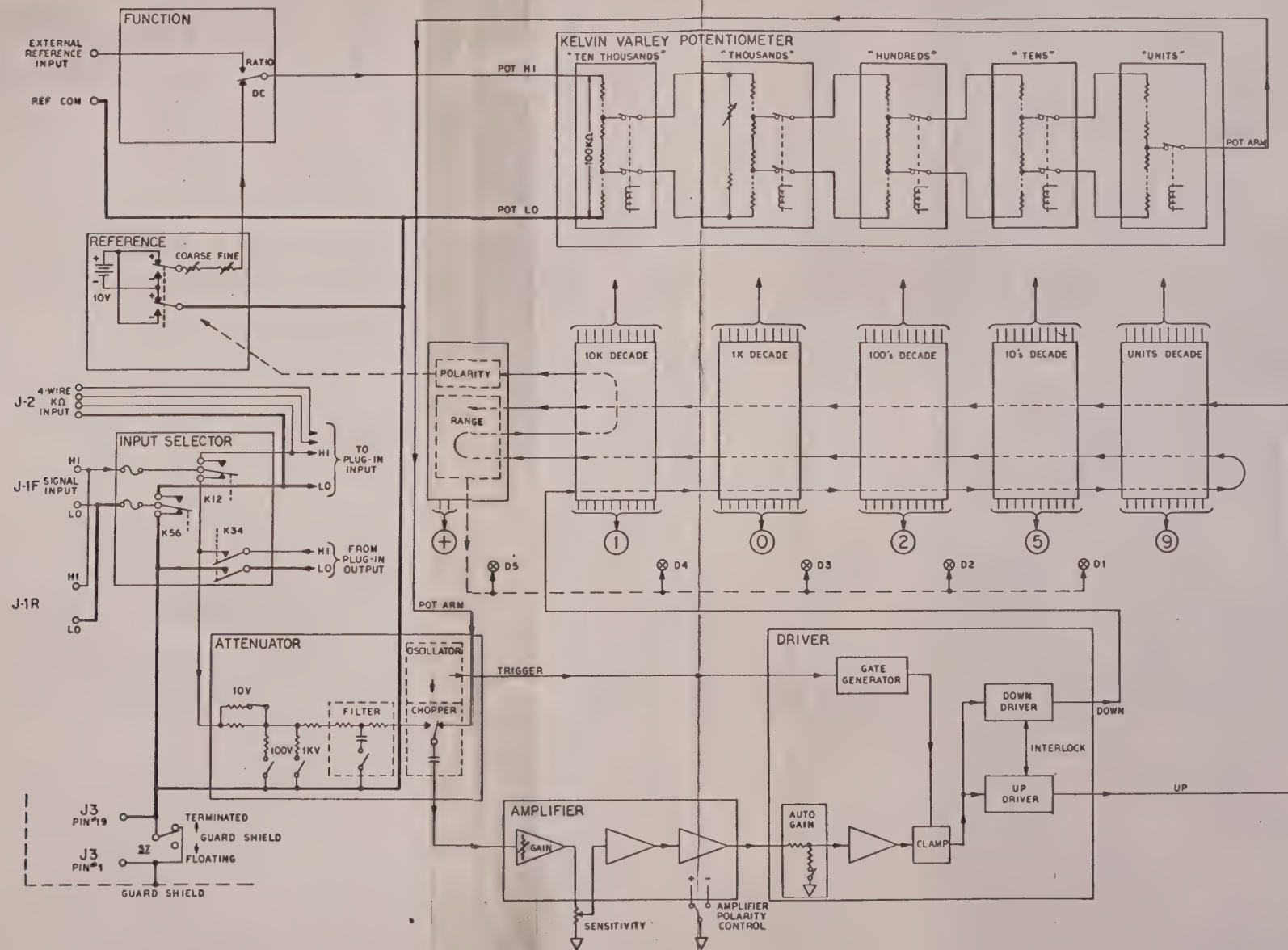
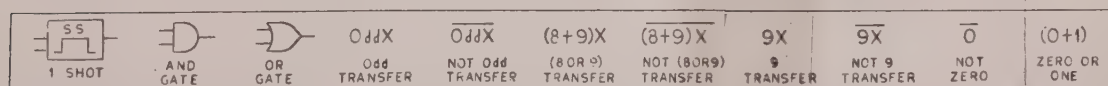
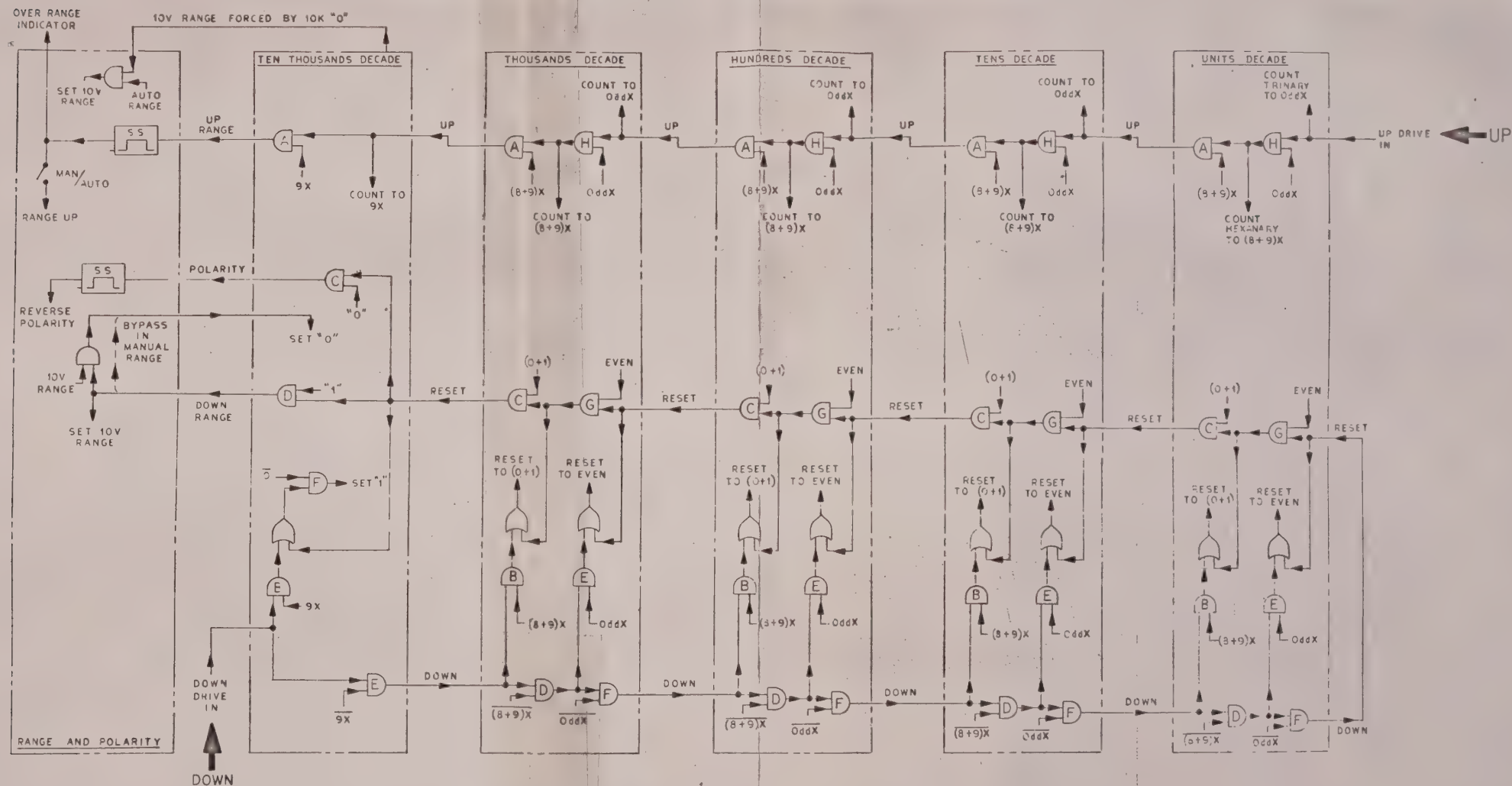


Figure 6-2. Bottom View.

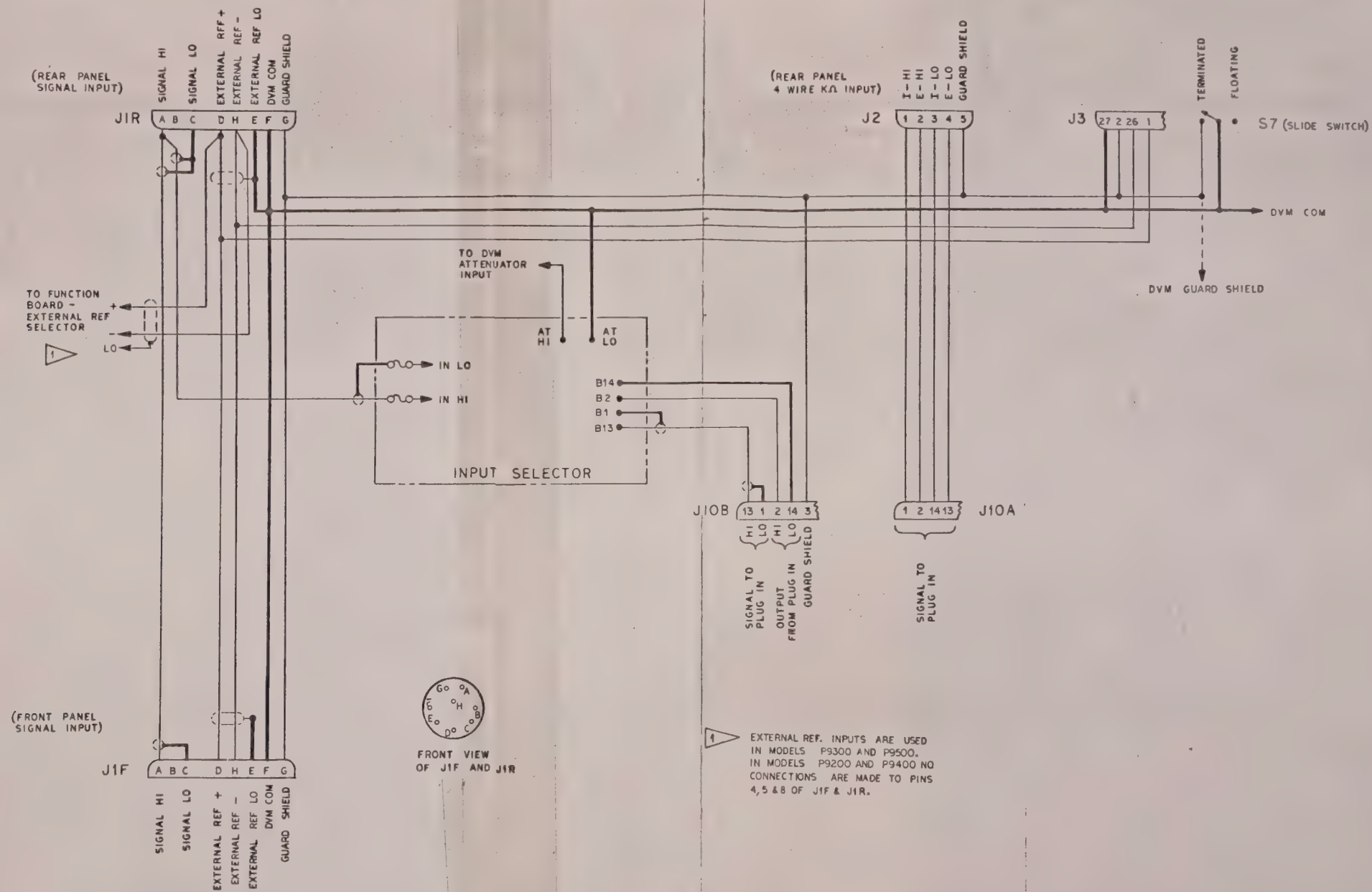


Schematic #1. Signal Circuits Block Diagram.





Schematic 2. Logic Block Diagram.



Schematic 3. Signal Input Connectors-Diagram.

INPUT SELECTOR

SUBASSEMBLY

PARTS LIST

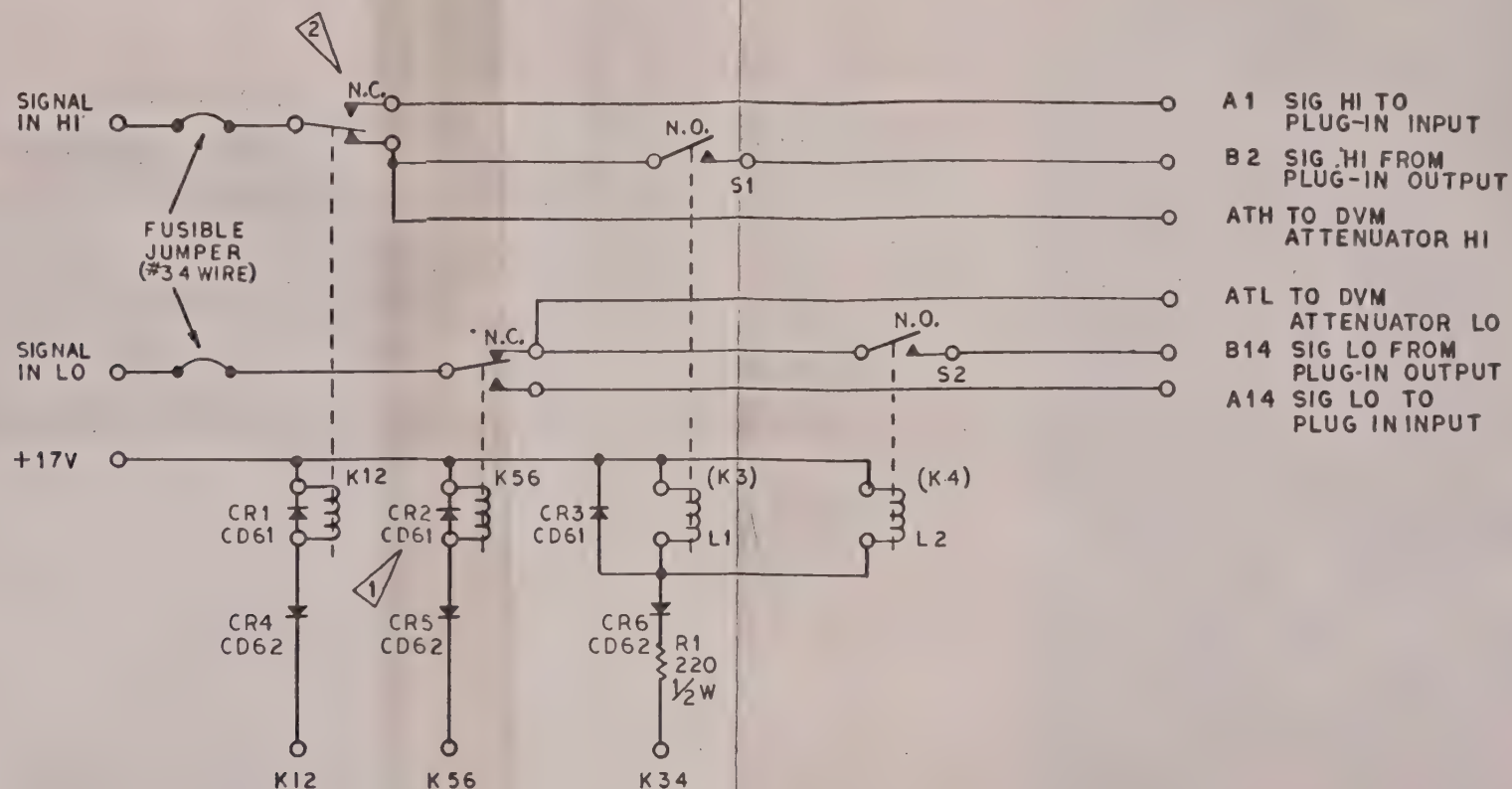
SUBASSEMBLY: Input Selector

SCHEMATIC NO. 90-0779

CIMRON PART NO. 90-6079

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R1001	220Ω	COMP	1/2W 5%	01121	EB-2215	7-41035
<u>SEMICONDUCTOR</u>						
CR1001 - CR1003		**CD-61 DIODE		15318		7-95511
CR1004 - CR1006		**CD-62 DIODE		15318		7-95507
<u>SOLENOID</u>						
K1012, K1056		3PDT, 12V		21226	12-BW3-G	7-38215
<u>REED</u>						
S1001, S1002		RELAY		12617	DRR-5	7-38211
<u>COIL</u>						
L1001, L1002		REED SWITCH ACTUATOR		15318		80-0508-1
<u>MISCELLANEOUS</u>						
		ETCHED BOARD INPUT SELECTOR		15318		90-7079-1
		SHIELD ASSEMBLY INPUT SELECTOR		15318		90-2006-1

NOTE**CD-61, I_f = 1V greater than 100 ma, I_r = 75V less than 1 ua, SILICON**CD-62, I_f = 1V greater than 100 ma, I_r = 300V less than 6 ua, SILICON



NOTES

1. PARTIAL REFERENCE DESIGNATIONS SHOWN. ALL NUMBERS ARE IN THE SERIES 1001 AND ON. EXAMPLE: CR2 IS CR1002, ETC.
2. RELAYS IN DC FUNCTION POSITION, K12 ENERGIZED.

CAUTION IN ORDER TO ASSURE LOW LEAKAGE AND HIGH INPUT IMPEDANCE USE **CLEAN NYLON GLOVES** WHEN HANDLING THIS BOARD ASSY.

Schematic 4. Input Selector.

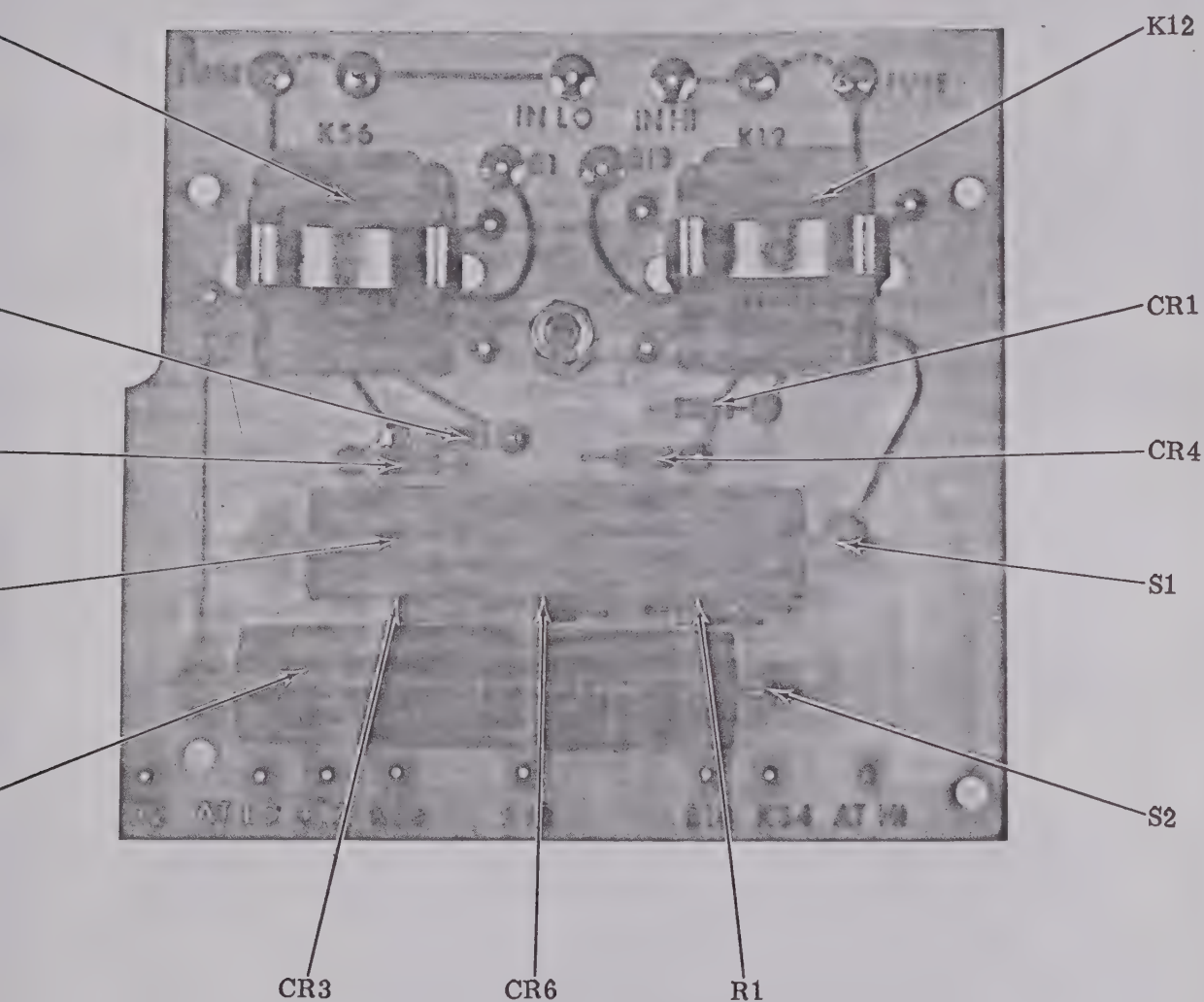


Figure 6-3. Input Selector.

ATTENUATOR

ASSEMBLY 90-6001

PARTS LIST

ASSEMBLY: Attenuator

SCHEMATIC NO. 90-0701

CIMRON PART NO. 90-6001

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C101, C102	5nf	POLY	200V 1%	12406	PD2A502F	1-57337
C103, C104	0.1uf	POLY	200V 20%	12406	PD2362	1-57309
C105	15nf	POLY	200V 20%	12406	PD2352	1-57310
C106	10nf	POLY	200V 1%	12406	PD2A103F	1-57338
C107	1nf	GLASS	500V 10%	07115	CYFM15C102K	1-57602
C108, C110	560pf	GLASS	500V 10%	07115	CYFM20C561K	1-57600
C111	10uf	MET PAP	100V 10%	12406	VX1A106K	1-57341

RESISTOR

R101	10M Ω	WW	0.05%	15318		5-40021
R102	560K Ω	COMP	2W 5%	01121	HB-5645	7-45076
R103	100.75K Ω	WW	1/4W 0.05%	15318		5-40021
R104	1.105M Ω	WW	1/2W 0.05%	15318		5-40021
R105	523K Ω	DEP	1/8W 1%	07716	TYPE RN-60B	7-46522
R106	7.5K Ω	MET FILM	1/8W 1%	07716	TYPE MEA	7-46137
R107	10.2K Ω	MET FILM	1/8W 1%	07716	TYPE MEA	7-46138
R108	255K Ω	MET FILM	1/8W 1%	07716	TYPE MEA	7-46139
R109	523K Ω	DEP	1/8W 1%	07716	TYPE RN-60B	7-46522
R110	7.5K Ω	MET FILM	1/8W 1%	07716	TYPE MEA	7-46137
R111	330K Ω	COMP	1/4W 5%	01121	CB-3345	7-41273
R112	220K Ω	COMP	1/4W 5%	01121	CB-2245	7-41271
R113	56K Ω	COMP	1/4W 5%	01121	CB-5635	7-41264
R114	2.2M Ω	COMP	1/4W 5%	01121	CB-2225	7-41283
R115	500 Ω	VAR TRIM WW	1/4W	15318	275-1-501	7-54240
R117	10K Ω	VAR TRIM WW	1/4W	15318		7-54242
R118	470 Ω	COMP	1/2W 5%	01121	EB-4715	7-41039
R119	Factory	Selected Value				
R120	25K Ω	LINEAR TAPER	1/8W	11237	220S253B	7-48808

SEMICONDUCTOR

CR101 - CR104	**CD-61 DIODE	15318		7-95511
CR105 - CR108	***CD-62 DIODE	15318		7-95507
CR109 - CR110	FD300 DIODE	07263	FD300	7-95505

TRANSISTOR

Q101	JEDEC	2N3686 or 2N4302	9-04728
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REED

S101	RELAY, SPST, RHODIUM	12617	DRR-5	7-38211
S102 - S104	RELAY, SPST, GOLD	12617	DRG-1	7-38208

COIL

L101	REED DRIVE	15318		80-0508-1
------	------------	-------	--	-----------

PARTS LIST

ASSEMBLY: Attenuator

SCHEMATIC NO. 90-0701

CIMRON PART NO. 90-6001

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>COIL (Cont'd)</u>						
L102 - L104		REED DRIVE		15318		70-0501-1
<u>MISCELLANEOUS</u>						
DS101, DS102		LAMP, GLOW, NE-2H			NE-2H	5-46501
		SHIELD ASSY - ATTENUATOR		15318		90-2005-3
A101		CHOPPER ASSY		15318		90-6023-1
		BOARD, CIRCUIT, ETCHED		15318		90-7001-7

These resistors must be replaced as one unit under Cimron Part Number 5-40021.

**CD-61 = I_f 1V greater than 100 ma

SILICON

I_r 75V less than 1 ua

***CD-62 = I_f 1V greater than 100 ma

SILICON

I_r 300V less than 6 ua

ATTENUATOR CHOPPER COMPENSATION ADJUSTMENT

The output of the attenuator assembly at null should be flat. The chopper and field effect transistor, however, cause the assembly output to be offset by a characteristic amount indicated by a bowing effect in the error signal. The chopper compensation adjustment is varied to flatten the assembly output. This adjustment is made at the factory and should not need readjusting except when the chopper or field effect transistor is changed.

The following equipment is required to perform the chopper compensation adjustment:

1. DC voltage standard, Kin Tel Model 321 or equivalent
2. Voltage divider, ESI Model RV722 or equivalent
3. Oscilloscope, Tektronix Model 502 or equivalent

The adjustment potentiometer is located on the lower portion of the attenuator assembly which must be extracted from the instrument to perform the adjustment, and then inserted to check the assembly output.

1. Connect the test setup as shown in figure 6-3A.

2. Position the front panel controls as follows:

FUNCTION	DC
RANGE	10
PRINT CONTROL	TRACK
SENSITIVITY	HI
POWER	FILTER OUT

3. Position the oscilloscope front panel controls for external positive DC trigger, 2 ms/cm time, 1V/cm sensitivity (X1 probe).
4. Adjust the DC power supply for +1.0000V output.
5. Adjust the output of the voltage divider for a null condition on the oscilloscope (figure 4-3) with a DVM indication of +0.5000.
6. If the oscilloscope indication is bowed, in either direction, vary the chopper compensation adjustment (R20 in figure 6-4) for an assembly output as flat as possible.

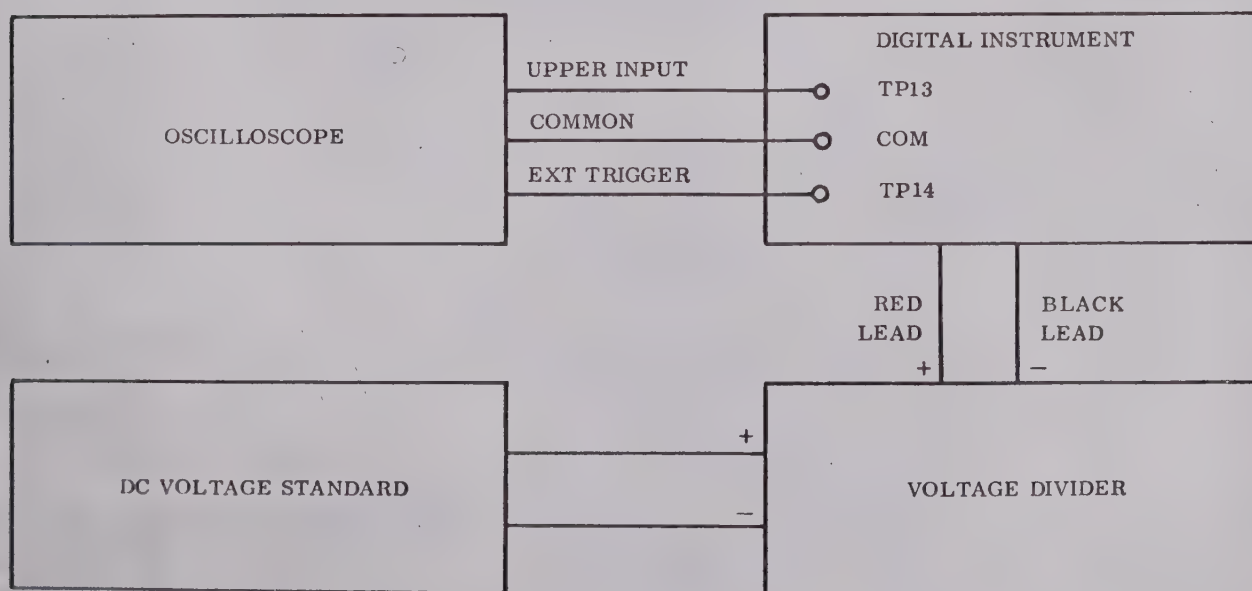
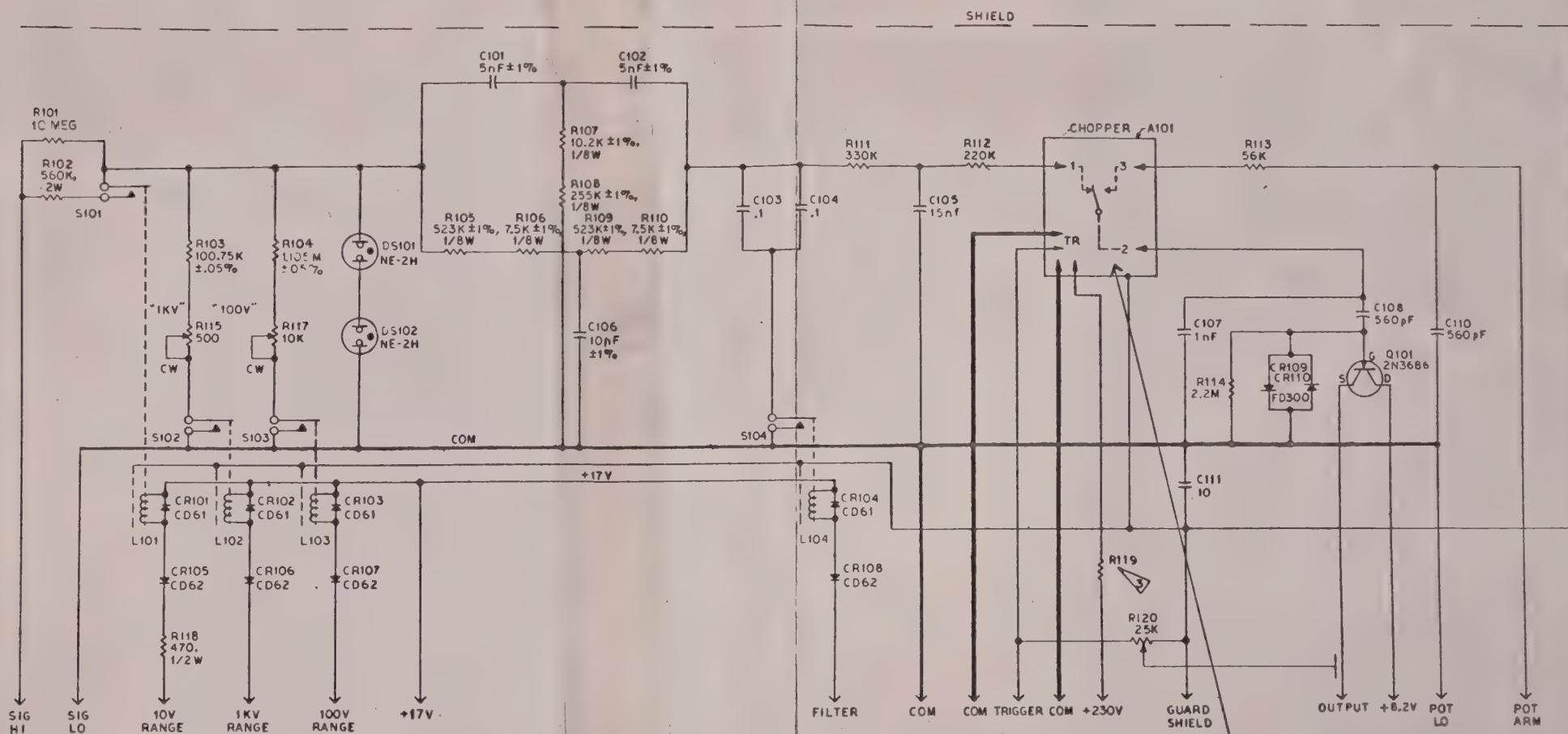


Figure 6-3A. Attenuator Chopper Compensation Adjustment Test Setup.

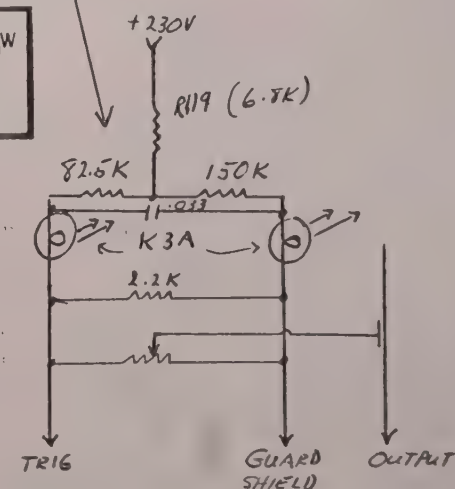


NOTES

1. ALL RESISTORS $\pm 5\%$, 1/4W UNLESS NOTED OTHERWISE.
2. ALL CAPACITORS ARE SHOWN IN μF UNLESS NOTED OTHERWISE.
3. SELECTED TO STANDARDIZE OSCILLATOR FREQUENCY TO APPROXIMATELY 100 CPS WITH 117 VOLT LINE.

CAUTION IN ORDER TO ASSURE LOW LEAKAGE AND HIGH INPUT IMPEDANCE USE CLEAN NYLON GLOVES WHEN HANDLING THIS BOARD ASSY.

Schematic 5. Attenuator.



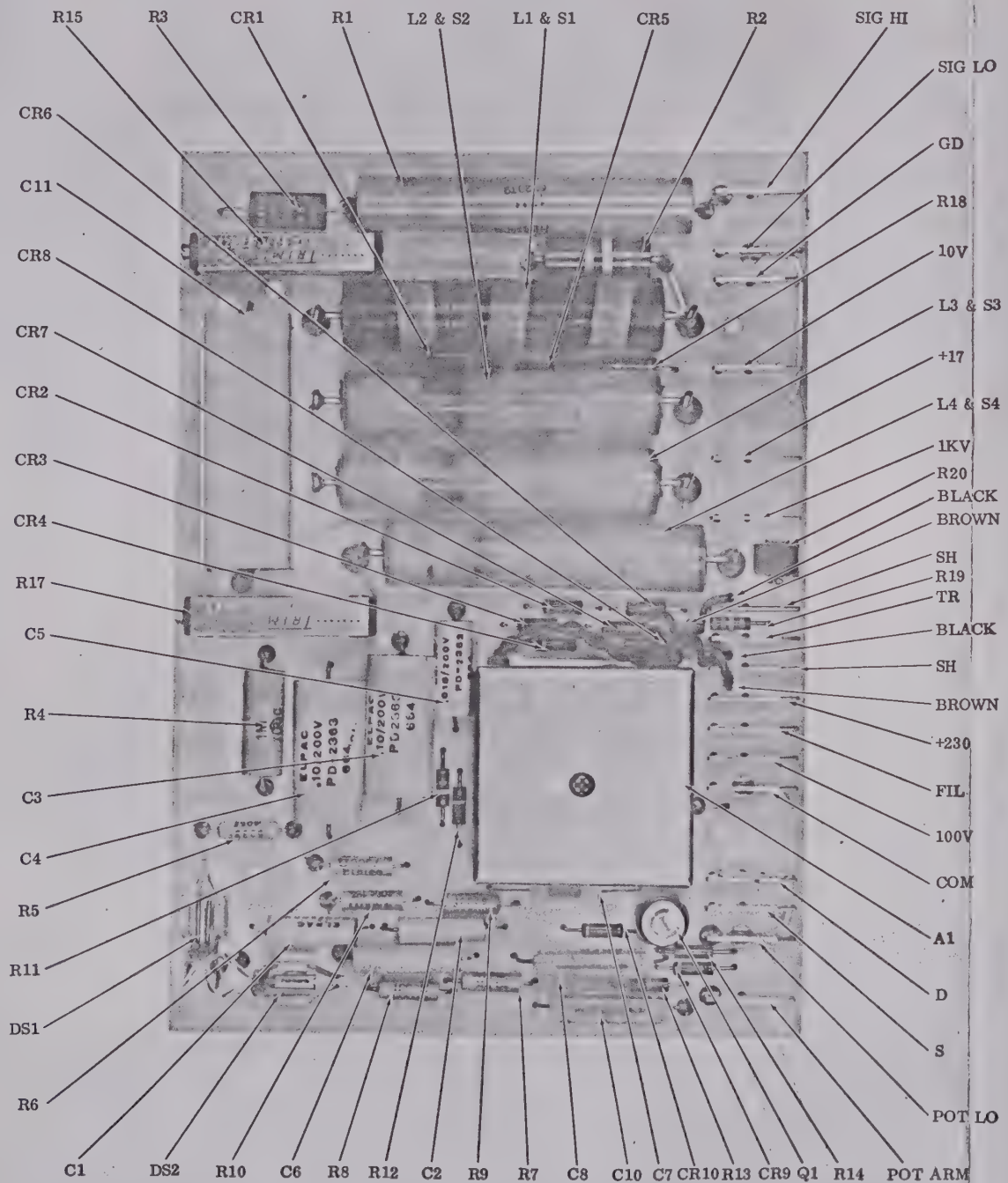


Figure 6-4. Attenuator.

AMPLIFIER

ASSEMBLY 90-6077

PARTS LIST

ASSEMBLY: Amplifier

SCHEMATIC NO. 90-0777

CIMRON PART NO. 90-6077

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C7701	0.22uf	MET PAP	50V	12406	VX5A224K	1-57319
C7702	20uf	ELECT	15V	14655	NLW 20-15	1-57246
C7703	2.2uf	TANT	35V 20%	01295	SCM225BP035D4	1-57104
C7704	20uf	ELECT	15V	14655	NLW 20-15	1-57246
C7705	0.47uf	MET PAP	50V 10%	12406	VX5A474K	1-57318
C7706	5nf	DISC	50V	71590	CK-502	1-57512
C7707	1nf	DISC	1000V 10%	71590	DD-102	1-57504
C7708	100uf	ELECT	15V	14655	NLW 100-15	1-57247
C7709	6uf	ELECT	15V	14655	NLW 6-15	1-57245
C7710, C7711	0.1uf	MET PAP	50V	12406	VX5A104K	1-57321
C7712, C7713	25uf	ELECT	25V 85°	14655	NLW 25-25	1-57223
<u>RESISTOR</u>						
R7701	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7702	18KΩ	COMP	1/4W 5%	01121	CB-1835	7-41258
R7703	22.1KΩ	DEP	1/8W 1%	JEDEC	RN60D	7-46506
R7704	1KΩ	DEP	1/8W 1%	00656	TYPE CPM	7-46511
R7705	332Ω	DEP	1/8W 1%	00656	TYPE CPM	7-46513
R7706	22.1KΩ	DEP	1/8W 1%	JEDEC	RN60D	7-46506
R7707	332Ω	DEP	1/8W 1%	00656	TYPE CPM	7-46513
R7708	22.1KΩ	DEP	1/8W 1%	JEDEC	RN60D	7-46506
R7709	5KΩ	VAR TRIM WW	1/4W	80294	275-1-502	7-54207
R7710	1.8KΩ	COMP	1/4W 5%	01121	CB-1825	7-41246
R7711	680Ω	COMP	1/4W 5%	01121	CB-6815	7-41241
R7712	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R7713	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R7714	82KΩ	COMP	1/4W 5%	01121	CB-8235	7-41266
R7715	680Ω	COMP	1/4W 5%	01121	CB-6815	7-41241
R7716	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R7717	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R7718	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R7719	39KΩ	COMP	1/4W 5%	01121	CB-3935	7-41262
R7720	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R7721	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R7722	1.5KΩ	COMP	1/4W 5%	01121	CB-1525	7-41245
R7723	5.6KΩ	COMP	1/4W 5%	01121	CB-5625	7-41252
R7724	12KΩ	COMP	1/4W 5%	01121	CB-1235	7-41256
R7725	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255

PARTS LIST

ASSEMBLY: Amplifier

SCHEMATIC NO. 90-0777

CIMRON PART NO. 90-6077

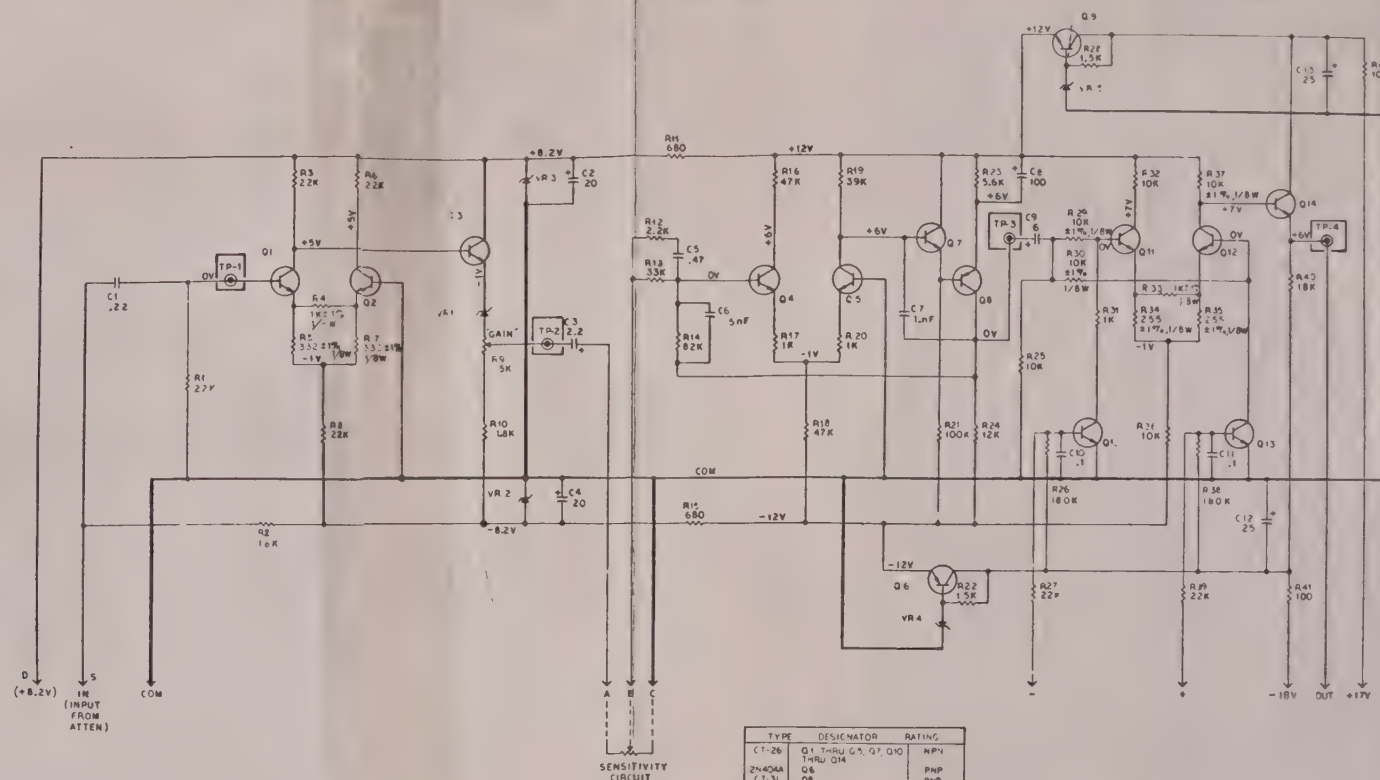
SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR (Cont'd)</u>						
R7726	180KΩ	COMP	1/4W 5%	01121	CB-1845	7-41270
R7727	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7728	1.5KΩ	COMP	1/4W 5%	01121	CB-1525	7-41245
R7729, R7730	10KΩ	DEP	1/8W 1%	00656	TYPE CPM	7-46501
R7731	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R7732	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7733	1KΩ	DEP	1/8W 1%	00656	TYPE CPM	7-46511
R7734, R7735	255Ω	DEP	1/8W 1%	07716	TYPE RN603	7-46523
R7736	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7737	10KΩ	DEP	1/8W 5%	00656	TYPE CPM	7-46501
R7738	180KΩ	COMP	1/4W 5%	01121	CB-1845	7-41270
R7739	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7740	18KΩ	COMP	1/4W 5%	01121	CB-1835	7-41258
R7741, R7742	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231
<u>SEMICONDUCTOR</u>						
VR7701		ZENER DIODE		JEDEC	1N708A	7-95631
VR7702, VR7703		ZENER DIODE		JEDEC	1N712A	7-95632
VR7704, VR7705		ZENER DIODE		JEDEC	1N716A	7-95614
<u>TRANSISTOR</u>						
Q7701 - Q7705		**CT-26		15318		9-04710
Q7706				JEDEC	2N404A	9-04609
Q7707		**CT-26		15318		9-04710
Q7708		**CT-31		15318		9-04800
Q7709		**CT-20		15318		9-04701
Q7710 - Q7714		**CT-26		15318		9-04710
<u>MISCELLANEOUS</u>						
TP1		TEST JACK, BROWN		82042	TJ-51-3	5-19003
TP2		TEST JACK, RED		82042	TJ-51-4	5-19004
TP3		TEST JACK, ORANGE		82042	TJ-51-2	5-19002
TP4		TEST JACK, YELLOW		82042	TJ-51-6	5-19006
		ETCHED BOARD, AMPLIFIER		15318		90-7077-1

NOTE

**CT-20 = 2N697

**CT-26 = 2N2222

**CT-31 = 2N1131



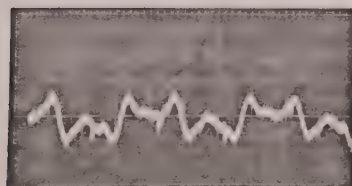
NOTES

1. ALL DIODES ARE CD-61 UNLESS NOTED OTHERWISE.
2. ALL RESISTORS ARE 5% 1/4W UNLESS NOTED OTHERWISE.
3. ALL CAPACITORS ARE SHOWN IN μF UNLESS NOTED OTHERWISE.
4. FOR SEMI CONDUCTOR TYPES SEE TABLE AT RIGHT.
5. PARTIAL REF DESIGNATORS SHOWN, ALL DESIGNATORS ARE IN THE SERIES 7700 AND ON, FOR COMPLETE DESIGNATOR ADD 7700 TO NUMBER SHOWN, EXAMPLE R1 IS R7701.

TYPE	DESIGNATOR	RATING
CT-26	Q1 THRU Q5, Q7, Q10	NPN
2N4004	Q6	PNP
CT-31	Q8	PNP
CT-20	Q9	NPN
1N705A	VR1	5.6V
1N712A	VR2, VR3	8.2V
1N716A	VR4, VR5	12V

Schematic 6. Amplifier.

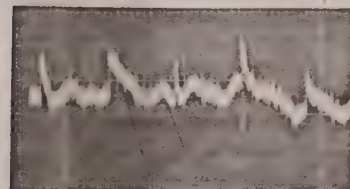
TP
①



SCOPE SETTING

VERTICAL SENSITIVITY 0.1uV/CM
HORIZONTAL SWEEP 5MS/CM

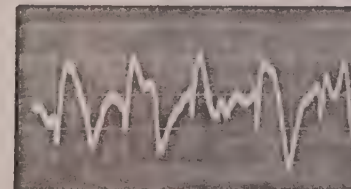
TP
②



SCOPE SETTING

VERTICAL SENSITIVITY 0.5uV/CM
HORIZONTAL SWEEP 5MS/CM

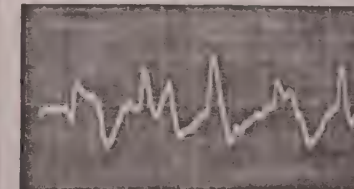
TP
③



SCOPE SETTING

VERTICAL SENSITIVITY 5MV/CM
HORIZONTAL SWEEP 5MS/CM

TP
④



SCOPE SETTING

VERTICAL SENSITIVITY 0.1V/CM
HORIZONTAL SWEEP 5MS/CM

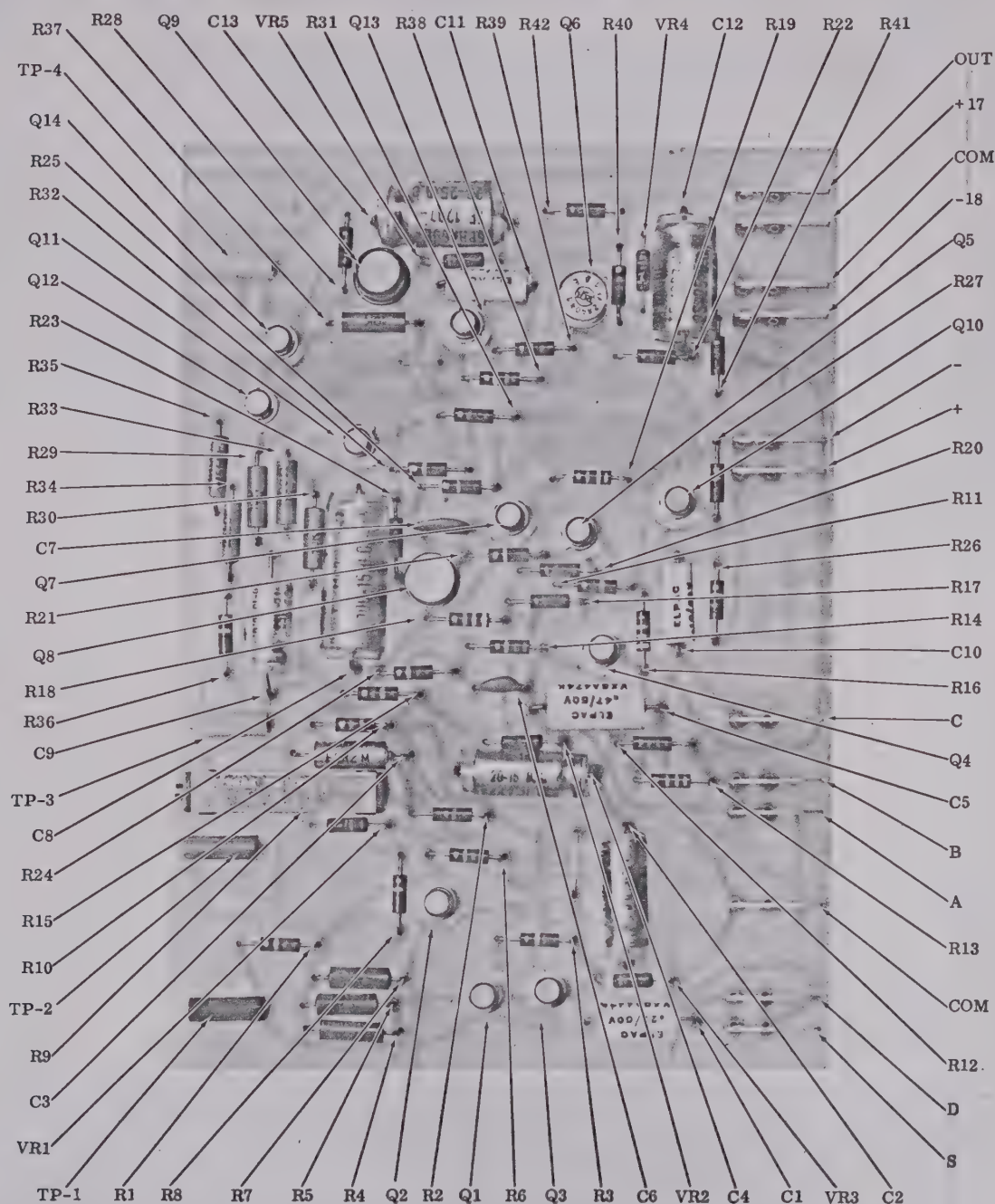


Figure 6-5. Amplifier.

DRIVER

ASSEMBLY 90-6075

PARTS LIST

ASSEMBLY: Driver

SCHEMATIC NO. 90-0775

CIMRON PART NO. 90-6075

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C7501, C7502	10uf	ELECT	25V	14655	NLW 10-25	1-57250
C7503	25uf	ELECT	25V	14655	NLW 25-25	1-57223
C7504	.47uf	MET PAP	50V 10%	12406	VX5A474K	1-57318
C7505	20uf	ELECT	15V	14655	NLW 20-15	1-57246
C7506	.068uf	MET PAP	50V 10%	12406	VX5A683K	1-57322
C7507	0.0018uf	DISC	1000V 10%	71590	DD-182	1-57503
C7508	.068uf	MET PAP	50V 10%	12406	VX5A683K	1-57322
C7509	2.2uf	TANT	20V 10%	56289	150D225X9020A2	1-57108
C7510	.015uf	MET PAP	50V 10%	12406	VX5A153K	1-57329
C7511	0.001uf	DISC	1000V 10%	71590	DD-102	1-57504
C7512	.047uf	MET PAP	50V 10%	12406	VX5A473K	1-57327
C7513	20uf	ELECT	15V	14655	NLW 20-15	1-57246
C7514	0.0018uf	DISC	1000V 10%	71590	DD-182	1-57503
C7515	.068uf	MET PAP	50V 10%	12406	VX5A683K	1-57322
C7516	.047uf	MET PAP	50V 10%	12406	VX5A473K	1-57327
C7517	.005uf	DISC	50V 20%	71590	CK-502	1-57512
<u>RESISTOR</u>						
R7501	10K Ω	COMP	1/4W 5%	01121	CB-1035	7-41255
R7502	2.2K Ω	COMP	1/4W 5%	01121	CB-2225	7-41247
R7503	6.8K Ω	COMP	1/4W 5%	01121	CB-6825	7-41253
R7504	12K Ω	COMP	1/4W 5%	01121	CB-1235	7-41256
R7505	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R7506	33K Ω	COMP	1/4W 5%	01121	CB-3335	7-41261
R7507	12K Ω	COMP	1/4W 5%	01121	CB-1235	7-41256
R7508	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R7509	56K Ω	COMP	1/4W 5%	01121	CB-5635	7-41264
R7510	68K Ω	COMP	1/4W 5%	01121	CB-6835	7-41265
R7511	12K Ω	COMP	1/4W 5%	01121	CB-1235	7-41256
R7512	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R7513	56K Ω	COMP	1/4W 5%	01121	CB-5635	7-41264
R7514	27K Ω	COMP	1/4W 5%	01121	CB-2735	7-41260
R7515	12K Ω	COMP	1/4W 5%	01121	CB-1235	7-41256
R7516	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R7517	56K Ω	COMP	1/4W 5%	01121	CB-5635	7-41264
R7518	27K Ω	COMP	1/4W 5%	01121	CB-2735	7-41260
R7519	12K Ω	COMP	1/4W 5%	01121	CB-1235	7-41256
R7520	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R7521	56K Ω	COMP	1/4W 5%	01121	CB-5635	7-41264

PARTS LIST

ASSEMBLY: Driver

SCHEMATIC NO. 90-0775

CIMRON PART NO. 90-6075

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR (Cont'd)</u>						
R7522	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R7523	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7524, R7525	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R7526	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R7527	255Ω	DEP CAR	1/8W 1%	00656	CPM	7-46523
R7528	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R7529	255Ω	DEP CAR	1/8W 1%	00656	CPM	7-46523
R7530	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R7531	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7532	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R7533	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7534	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R7535	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R7536, R7537	22.1KΩ	DEP CAR	1/8W 1%	00656	CPM	7-46506
R7538	5KΩ	VAR TRIM WW	1/4W	80294	275-1-502	7-54207
R7539	3.32KΩ	DEP CAR	1/8W 10%	00656	CPM	7-46504
R7540	47.5KΩ	DEP CAR	1/8W 1%	00656	CPM	7-46502
R7541	820Ω	COMP	1/4W 5%	01121	CB-8215	7-41242
R7542	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R7543	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7544	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R7545	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R7546	39KΩ	COMP	1/4W 5%	01121	CB-3935	7-41262
R7547, R7548	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R7549	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R7550	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7551	1.5KΩ	COMP	1/4W 5%	01121	CB-1525	7-41245
R7552	3.3KΩ	COMP	1/4W 5%	01121	CB-3325	7-41249
R7553	1MΩ	COMP	1/4W 5%	01121	CB-1055	7-41279
R7554	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R7555	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R7556	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7557	12KΩ	COMP	1/4W 5%	01121	CB-1235	7-41256
R7558	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7559	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7560	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7561	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R7562	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R7563, R7564	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259

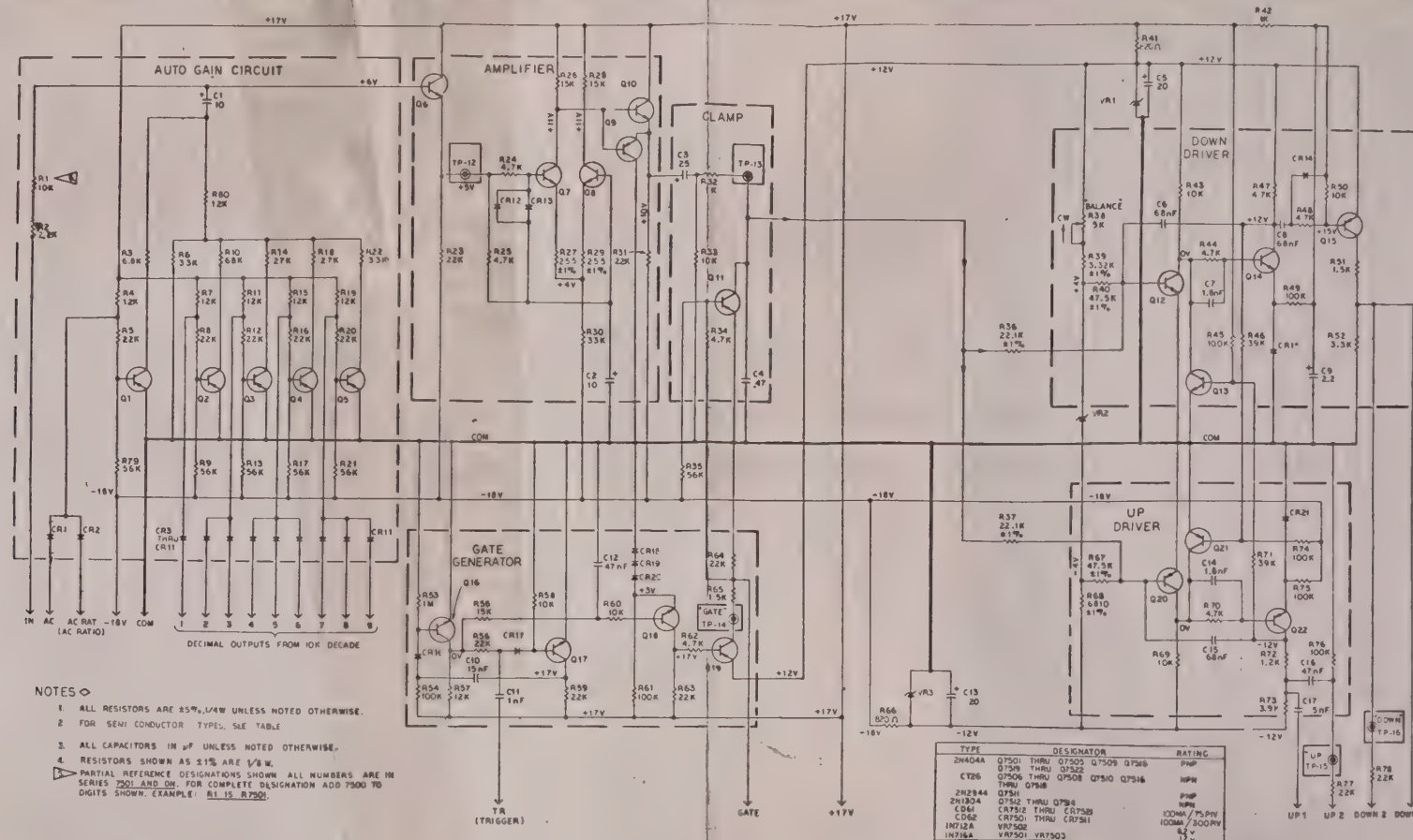
PARTS LIST

ASSEMBLY: Driver

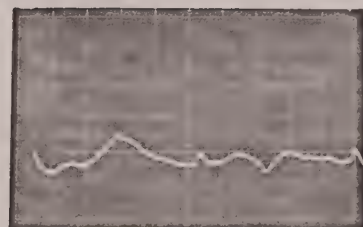
SCHEMATIC NO. 90-0775

CIMRON PART NO. 90-6075

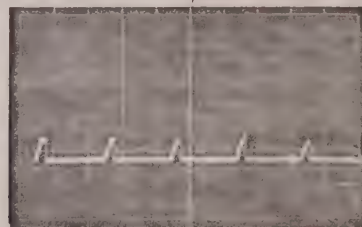
SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR (Cont'd)</u>						
R7565	1.5KΩ	COMP	1/4W 5%	01121	CB-1525	7-41245
R7566	820Ω	COMP	1/4W 5%	01121	CB-8215	7-41242
R7567	47.5KΩ	DEP CAR	1/8W 1%	00656	CPM	7-46502
R7568	6.81KΩ	DEP CAR	1/8W 1%	00656	CPM	7-46515
R7569	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R7570	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R7571	39KΩ	COMP	1/4W 5%	01121	CB-3935	7-41262
R7572	1.2KΩ	COMP	1/4W 5%	01121	CB-1225	7-41244
R7573	3.9KΩ	COMP	1/4W 5%	01121	CB-3925	7-41250
R7574 - R7576	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R7577, R7578	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R7579	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R7580	12KΩ	COMP	1/4W 5%	01121	CB-1235	7-41256
<u>SEMICONDUCTOR</u>						
CR7501 - CR7511		**CD-62 DIODE		15318		7-95507
CR7512 - CR7521		**CD-61 DIODE		15318		7-95511
VR7501		ZENER DIODE		JEDEC	1N716A	7-95614
VR7502		ZENER DIODE		JEDEC	1N712A	7-95632
VR7503		ZENER DIODE		JEDEC	1N716A	7-95614
<u>TRANSISTOR</u>						
Q7501 - Q7505		2N404A		JEDEC	2N404A	9-04609
Q7506 - Q7508		**CT-26		15318		9-04710
Q7509		2N404A		JEDEC	2N404A	9-04609
Q7510		**CT-26		15318		9-04710
Q7511		2N2944		JEDEC	2N2944A	9-04618
Q7512 - Q7514		2N1304		JEDEC	2N1304	9-04500
Q7515		2N404A		JEDEC	2N404A	9-04609
Q7516 - Q7518		**CT-26		15318		9-04710
Q7519 - Q7522		2N404A		JEDEC	2N404A	9-04609
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, DRIVER		15318		90-7075-1



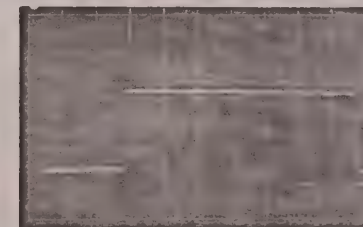
Schematic 7. Driver.



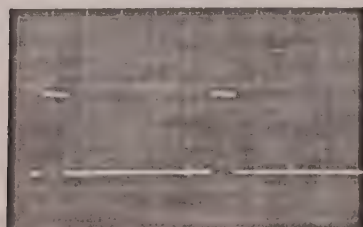
TP 12 SCOPE SETTING
VERTICAL SENSITIVITY 0.1uV/cm
HORIZONTAL SWEEP 2ms/cm



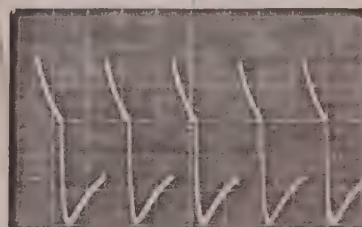
TP 13 SCOPE SETTING
VERTICAL SENSITIVITY 0.5V/cm
HORIZONTAL SWEEP 5ms/cm



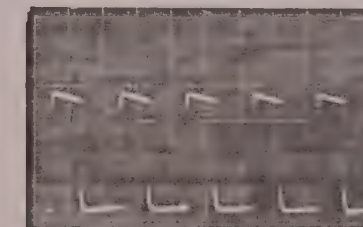
TP 14 A SCOPE SETTING
VERTICAL SENSITIVITY 5V/cm
HORIZONTAL SWEEP 0.2ms/cm



TP 14 B SCOPE SETTING
VERTICAL SENSITIVITY 5V/cm
HORIZONTAL SWEEP 3ms/cm



TP 15 SCOPE SETTING
VERTICAL SENSITIVITY 2V/cm
HORIZONTAL SWEEP 5ms/cm



TP 16 SCOPE SETTING
VERTICAL SENSITIVITY 2V/cm
HORIZONTAL SWEEP 5ms/cm

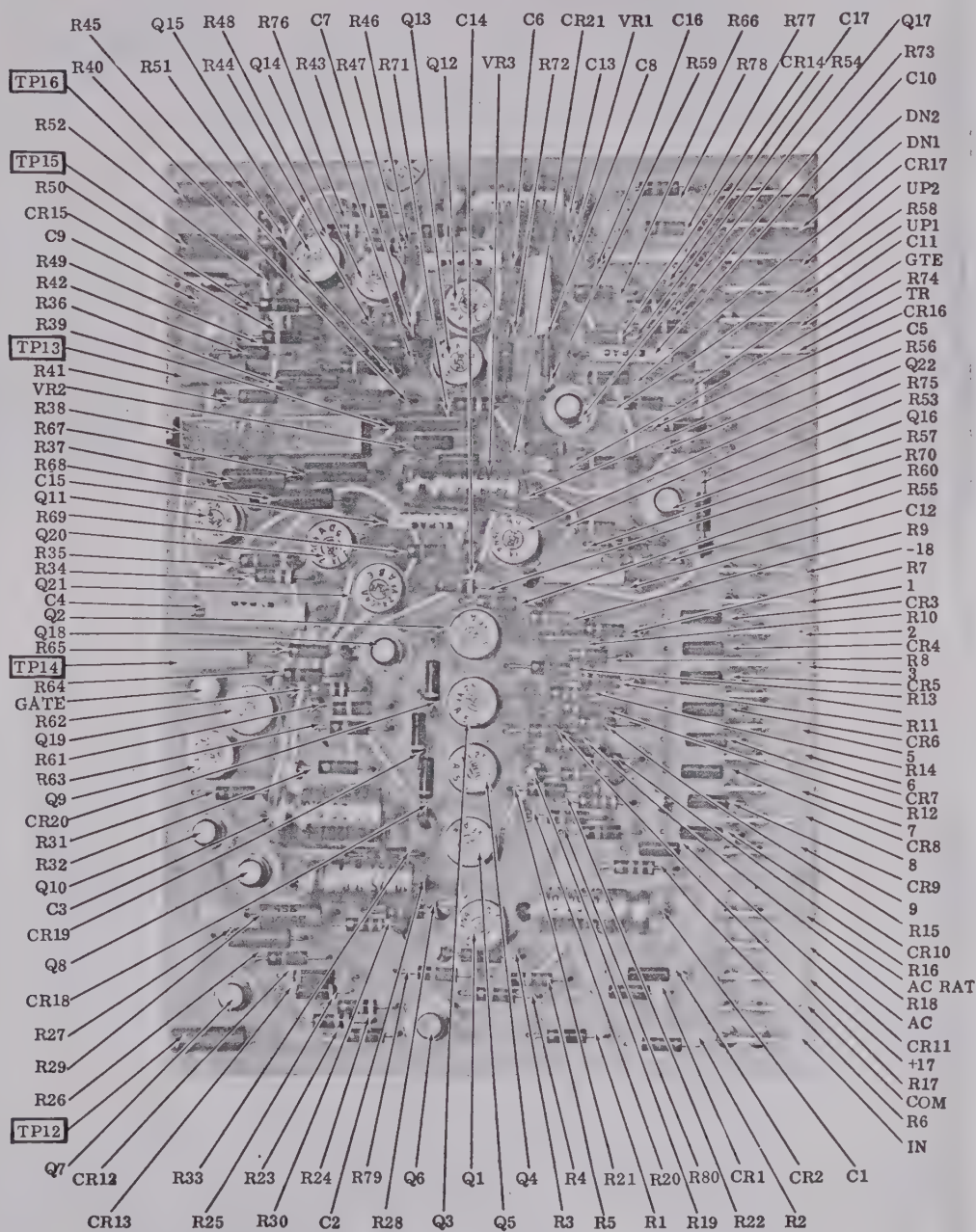


Figure 6-6. Driver.

STANDARD DECADE

ASSEMBLY 90-6047

PARTS LIST

ASSEMBLY: Standard Decade

SCHEMATIC NO. 90-0747

CIMRON PART NO. 90-6047

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C4701	1nf	DISC	1000V 10%	71590	DD-102	1-57504
C4702	.22uf	MET PAP	50V 10%	12406	VX5A224K	1-57319
C4703	2.2uf	TANT	35V 20%	01295	SCM225BP035D4	1-57104
C4704	.1uf	MET PAP	50V 10%	12406	VX5A104K	1-57321
C4705	1.8nf	DISC	10%	71590	DD-182	1-57503
C4706	.1uf	MET PAP	50V 10%	12406	VX5A104K	1-57321
C4707	1.8nf	DISC	10%	71590	DD-182	1-57503
C4708	4.7nf	MET MY	10%	14752	215BIC472K2	1-57353
C4709	1nf	DISC	1000V 10%	71590	DD-102	1-57504
C4710 - C4714	1.8nf	DISC	10%	71590	DD-182	1-57503
C4715	.1uf	MET PAP	50V 10%	12406	VX5A104K	1-57321
C4716	2.2uf	TANT	35V 20%	01295	SCM225BP035D4	1-57104
C4717	4.7nf	MET MY	10%	14752	215BIC472K2	1-57353
C4718, C4719	.22uf	MET PAP	50V 10%	12406	VX5A224K	1-57319
C4720	.1uf	MET PAP	200V 10%	12406	VX2A104K	1-57340
<u>RESISTOR</u>						
R4701	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R4702, R4703	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4704	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R4705	1.8KΩ	COMP	1/4W 5%	01121	CB-1825	7-41246
R4706, R4707	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4708	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4709	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R4710	1.5KΩ	COMP	1/4W 5%	01121	CB-1525	7-41245
R4711	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R4712	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R4713	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231
R4714	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4715, R4716	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4717	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R4718, R4719	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4720	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4721, R4722	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4723, R4724	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4725	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257

PARTS LIST

ASSEMBLY: Standard Decade

SCHEMATIC NO. 90-0747

CIMRON PART NO. 90-6047

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTOR (Cont'd)						
R4726	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4727	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4728	3.3KΩ	COMP	1/4W 5%	01121	CB-3325	7-41249
R4729	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4730	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4731	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4732	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R4733	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R4734, R4735	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4736	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4737, R4738	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4739	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4740	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4741, R4742	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4743	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4744	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4745, R4746	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4747	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4748	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4749, R4750	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4751	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4752	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4753, R4754	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4755	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4756	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4757	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231
R4758	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R4759	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4760	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R4761	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4762	1.8KΩ	COMP	1/4W 5%	01121	CB-1825	7-41246
R4763	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4764	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231
R4765	18KΩ	COMP	1/4W 5%	01121	CB-1835	7-41258
R4766 - R4768	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4769	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4770	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251

PARTS LIST

ASSEMBLY: Standard Decade

SCHEMATIC NO. 90-0747

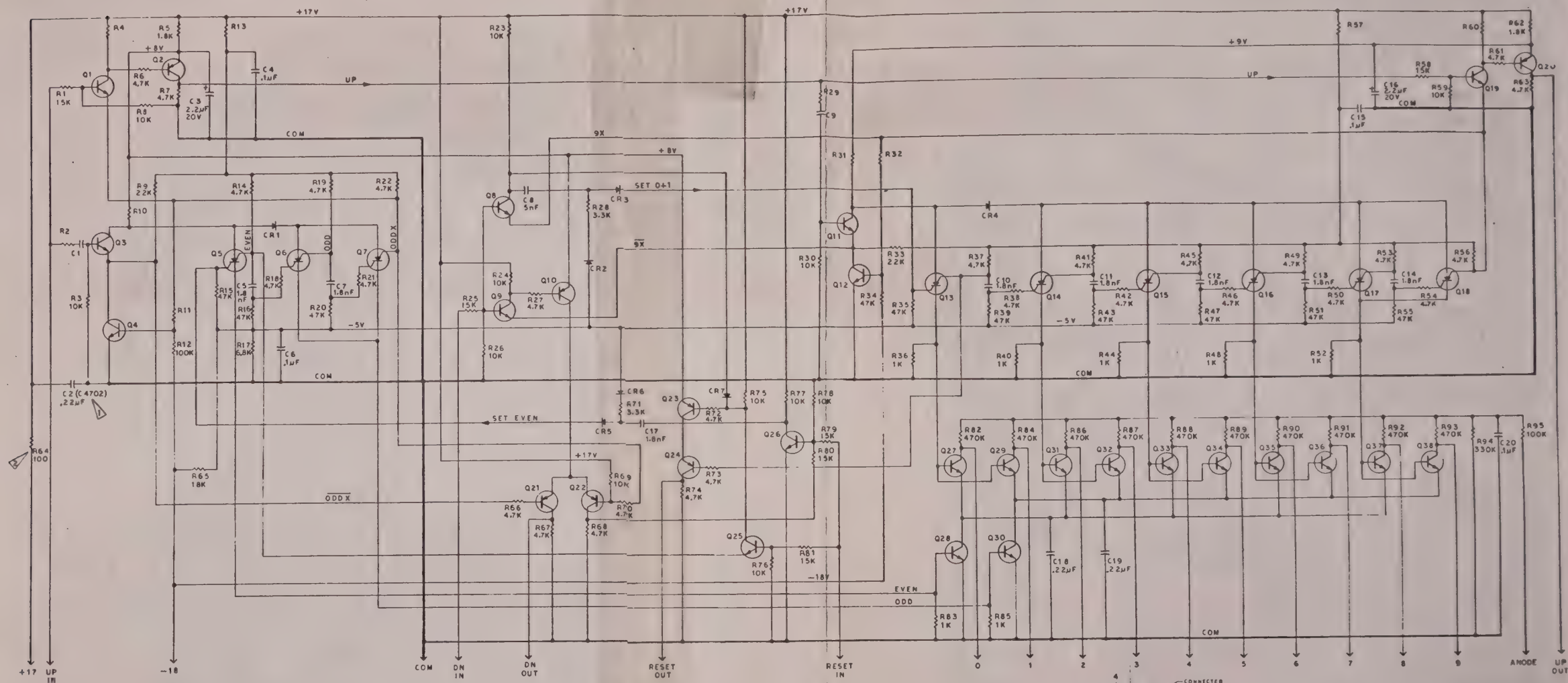
CIMRON PART NO. 90-6047

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR (Cont'd)</u>						
R4771	3.3KΩ	COMP	1/4W 5%	01121	CB-3325	7-41249
R4772 - R4774	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4775 - R4778	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4779 - R4781	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R4782	470KΩ	COMP	1/4W 5%	01121	CB-4745	7-41275
R4783	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4784	470KΩ	COMP	1/4W 5%	01121	CB-4745	7-41275
R4785	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R4786 - R4793	470KΩ	COMP	1/4W 5%	01121	CB-4745	7-41275
R4794	330KΩ	COMP	1/4W 5%	01121	CB-3345	7-41273
R4795	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
<u>SEMICONDUCTOR</u>						
CR4701 - CR4707		**CD-61		15318		7-95511
<u>TRANSISTOR</u>						
Q4701		4JD7A35		15318		9-04718
Q4702		2N404A		JEDEC	2N404A	9-04609
Q4703, Q4704		**CT-26		15318		9-04710
Q4705 - Q4707		SILICON CONTROLLED SWITCH		JEDEC	3N83	9-04401
Q4708, Q4709		4JD7A35		15318		9-04718
Q4710		2N404A		JEDEC	2N404A	9-04609
Q4711, Q4712		**CT-26		15318		9-04710
Q4713 - Q4718		SILICON CONTROLLED SWITCH		JEDEC	3N83	9-04401
Q4719		4JD7A35		15318		9-04718
Q4720 - Q4722, Q4724		2N404A		JEDEC	2N404A	9-04609
Q4723		2N3638A		JEDEC		9-04803
Q4725, Q4726		4JD7A35		15318		9-04718
Q4727 - Q4738		**CT-25		15318		9-04709
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, STANDARD				
		DECADE		15318		90-7047-1

NOTE**CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON

**CT-25 = 2N3114

**CT-26 = 2N2222



NOTES
 PARTIAL REFERENCE DESIGNATIONS SHOWN. ALL NUMBERS ARE IN SERIES 4701 AND ON. FOR COMPLETE DESIGNATION ADD 4700 TO DIGITS SHOWN. EXAMPLE: 52 IS C4702.
 EXCEPT AS NOTED, RESISTORS ARE $\pm 5\%$ TOLERANCE, $\frac{1}{4}$ WATT.

Schematic 8. Decade.

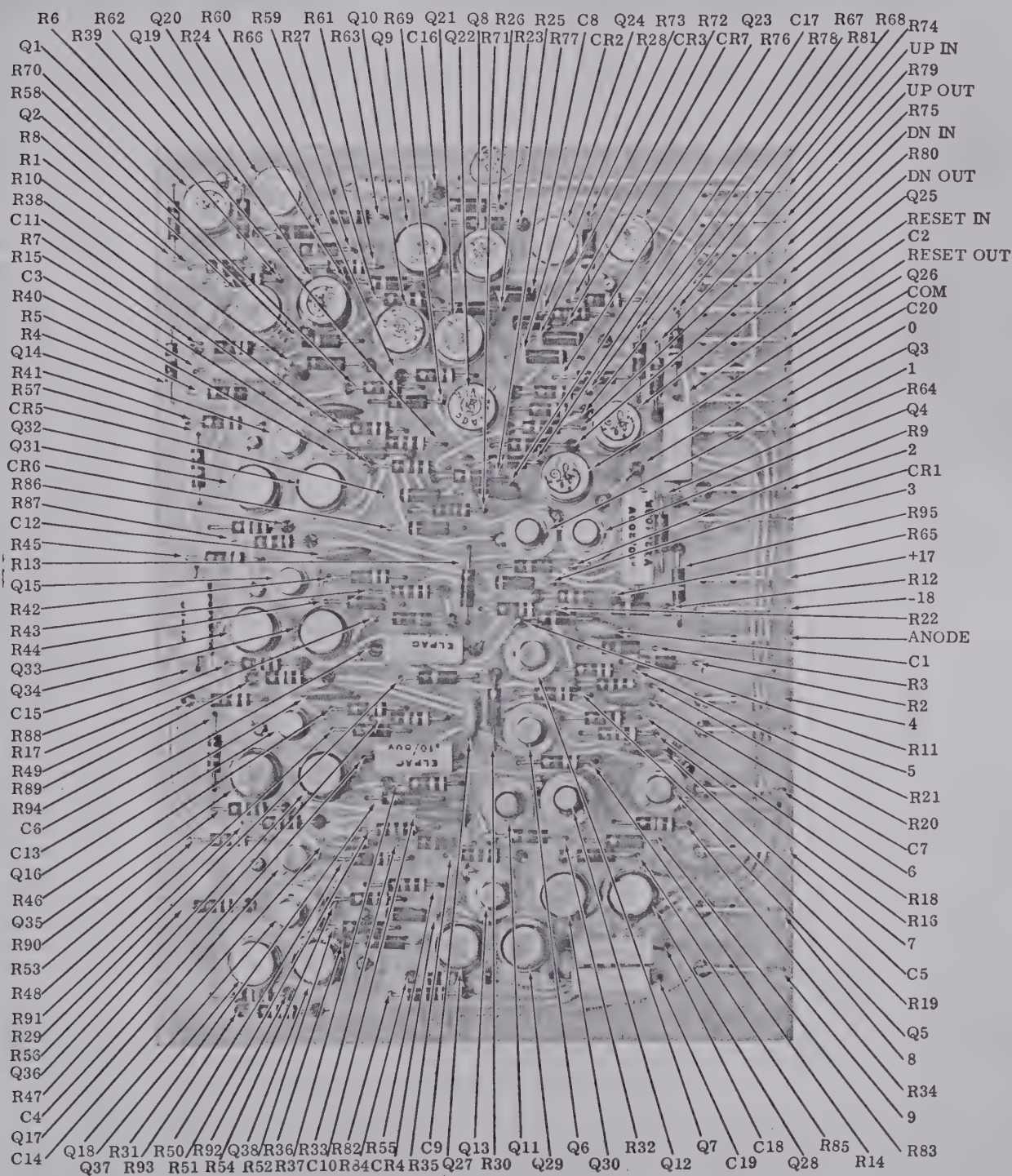


Figure 6-7. Decade.

TEN THOUSAND DECADE

ASSEMBLY 90-6048

PARTS LIST

ASSEMBLY: 10K Decade

SCHEMATIC NO. 90-0748

CIMRON PART NO. 90-6048

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C4801	25uf	ELECT	25V 85°C	14655	NLW25-25	1-57223
C4802, C4803	4.7nf	MET MY	200V 10%	14752	215BIC472K2	1-57353
C4804	560pf	DISC	1000V 10%	71590	DD-561	1-57500
C4805	.1uf	MET PAP	50V 10%	12406	VX5A104K	1-57321
C4806 - C4815	1.8nf	DISC	1000V 10%	71590	DD-182	1-57503
C4816	.1uf	MET PAP	200V 10%	12406	VX2A104K	1-57340
<u>RESISTOR</u>						
R4801	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R4802	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4803	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R4804	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4805	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R4806	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4807	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R4808	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4809, R4810, R4812-R4816	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4811, R4817, R4818	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4819, R4820	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R4821	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4822	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4823	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R4824, R4825	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4826	1.8KΩ	COMP	1/4W 5%	01121	CB-1825	7-41246
R4827	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R4828	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4829 - R4831	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4832	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4833	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R4834	150KΩ	COMP	1/4W 5%	01121	CB-1545	7-41269
R4835	18KΩ	COMP	1/4W 5%	01121	CB-1835	7-41258
R4836	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R4837	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R4838	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4839	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4840	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251

PARTS LIST

ASSEMBLY: 10K Decade

SCHEMATIC NO. 90-0748

CIMRON PART NO. 90-6048

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR (Cont'd)</u>						
R4841	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4842	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4843	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4844	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4845	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4846	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4847	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4848	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4849	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4850	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4851	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4852	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4853	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4854	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4855	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4856	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4857	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4858	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4859	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4860	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4861	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4862	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4863	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4864	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4865	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R4866	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4867	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R4868	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R4869	220KΩ	COMP	1/4W 5%	01121	CB-2245	7-41271
R4870	68KΩ	COMP	1/4W 5%	01121	CB-6835	7-41265
R4871	470KΩ	COMP	1/4W 5%	01121	CB-4745	7-41275
R4872	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R4873	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255

PARTS LIST

ASSEMBLY: 10K Decade

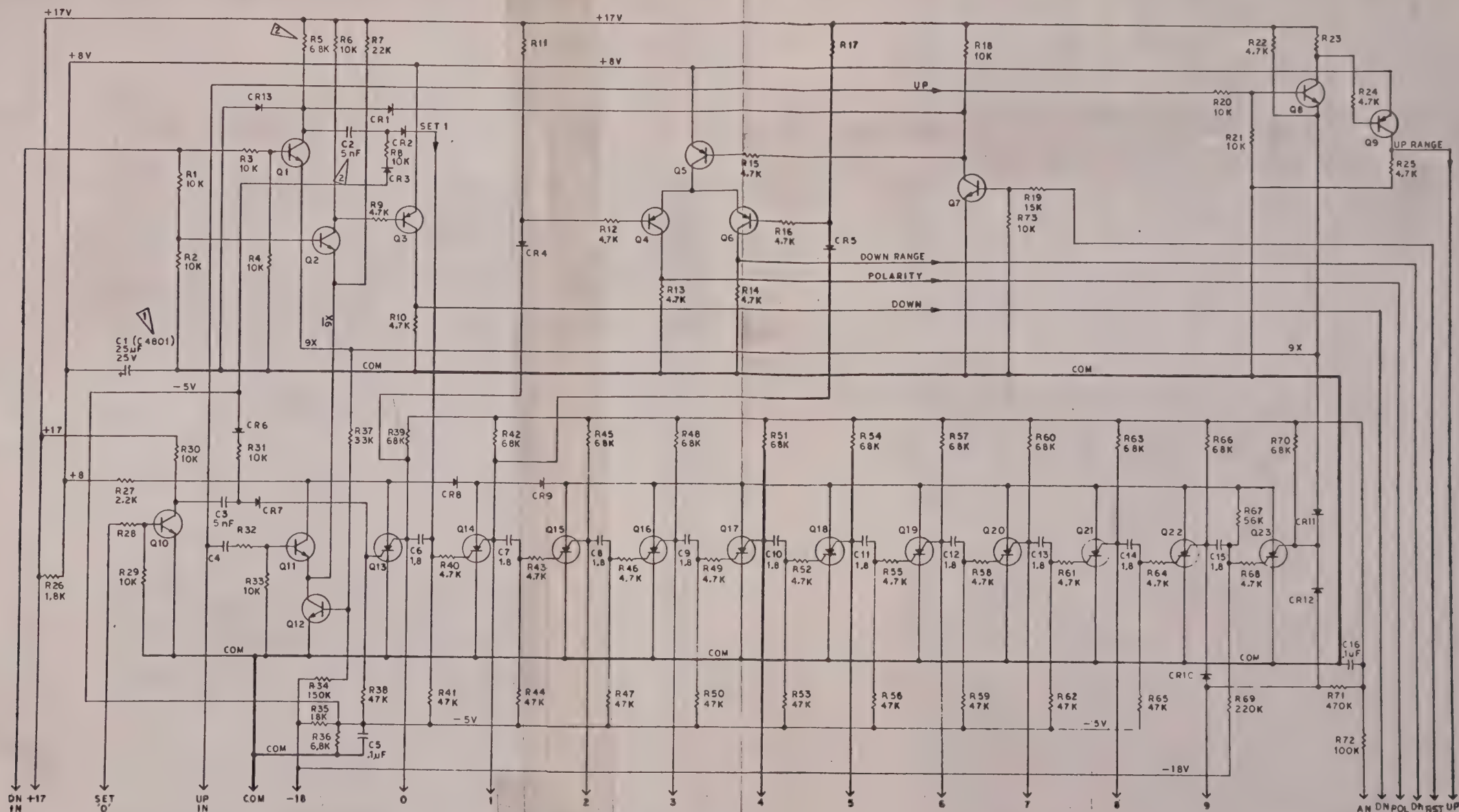
SCHEMATIC NO. 90-0748

CIMRON PART NO. 90-6048

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>SEMICONDUCTOR</u>						
CR4801 - CR4803		*CD-62 DIODE		15318		7-95507
CR4804, CR4805		**CD-61 DIODE		15318		7-95511
CR4806 - CR4810		*CD-62 DIODE		15318		7-95507
CR4811 - CR4813		**CD-61 DIODE		15318		7-95511
<u>TRANSISTOR</u>						
Q4801, Q4802		4JD7A35		15318		9-04718
Q4803, Q4804, Q4806		2N404A		JEDEC	2N404A	9-04609
Q4805		2N3638A		JEDEC	2N3638A	9-04803
Q4807		***CT-26		15318		9-04710
Q4808		4JD7A35		15318		9-04718
Q4809		2N404A		JEDEC	2N404A	9-04609
Q4810 - Q4812		***CT-26		15318		9-04710
Q4813 - Q4823		SILICON CONTROLLED SWITCH		JEDEC	3N83	9-04401
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, 10K DECADE		15318		90-7048-3

NOTE**CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON*CD-62, $I_f = 1V$ greater than 100 ma, $I_r = 300V$ less than 6 ua, SILICON

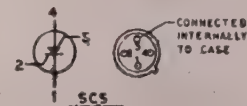
***CT-26 = 2N2222



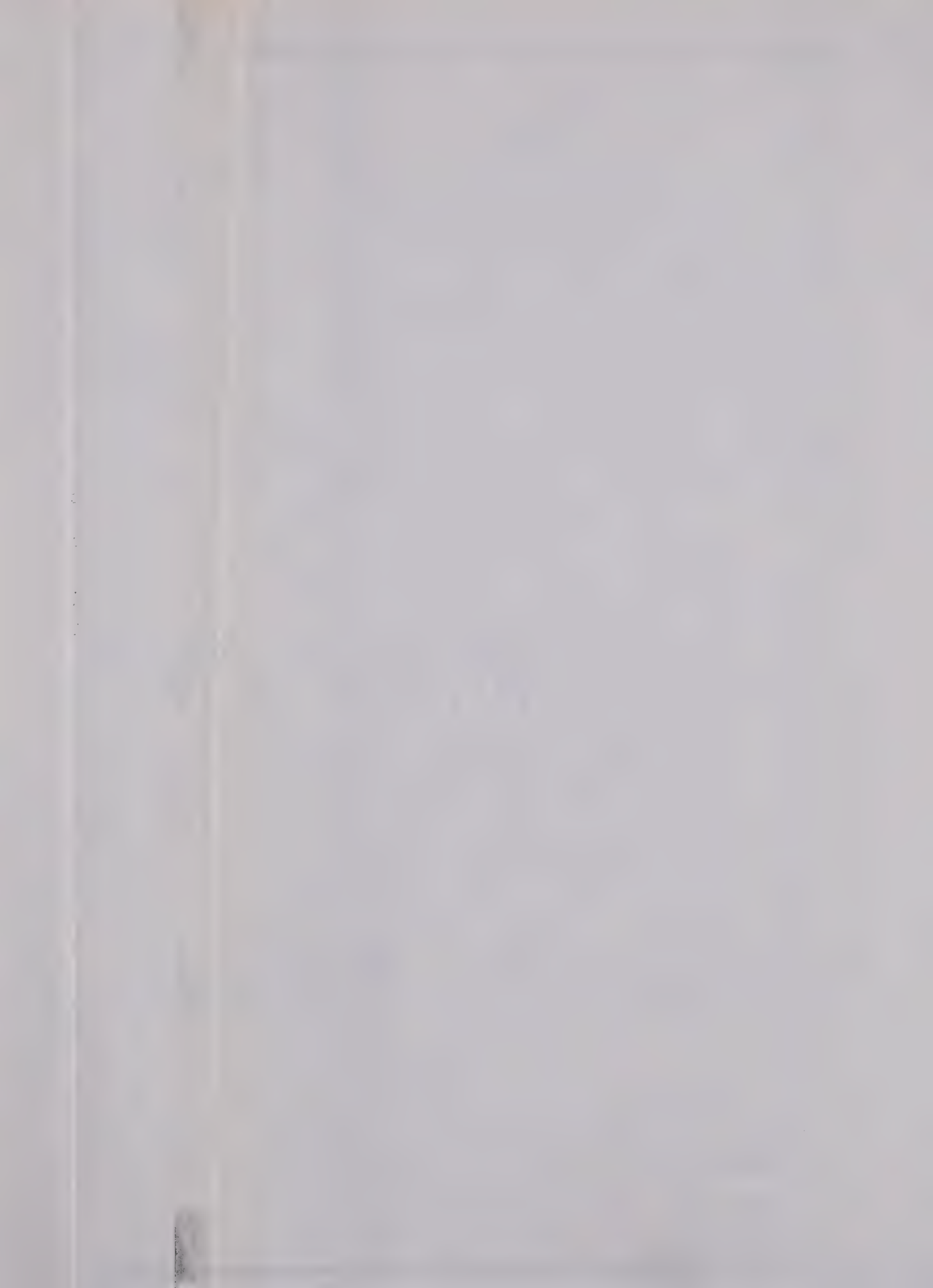
NOTES

1. PARTIAL REFERENCE DESIGNATIONS SHOWN. ALL NUMBERS ARE IN SERIES 4801 AND ON. FOR COMPLETE DESIGNATION ADD 4800 TO DIGITS SHOWN. EXAMPLE: C1 IS C4801
2. EXCEPT AS NOTED, CAPACITANCES ARE SHOWN IN NANOFARADS. RESISTORS ARE $\pm 5\%$ TOLERANCE, $\frac{1}{4}$ WATT.
3. FOR SEMI CONDUCTOR TYPES SEE TABLE

TYPE	DESIGNATOR	RATING
4J07A35	Q4801 Q4802 Q4808	NPN
2N404A	Q4803 THRU Q4806 Q4809	PNP
CT26	Q4807 Q4810 THRU Q4812	NPN
3N83	Q4813 THRU Q4823	SCS
CD61	CR4804 CR4805 CR4811 CR4812	100 NA/75 PW
CB62	CR4801 THRU CR4803 CR4806 THRU CR4810	100 NA/300 PW



Schematic 9. 10K Decade.



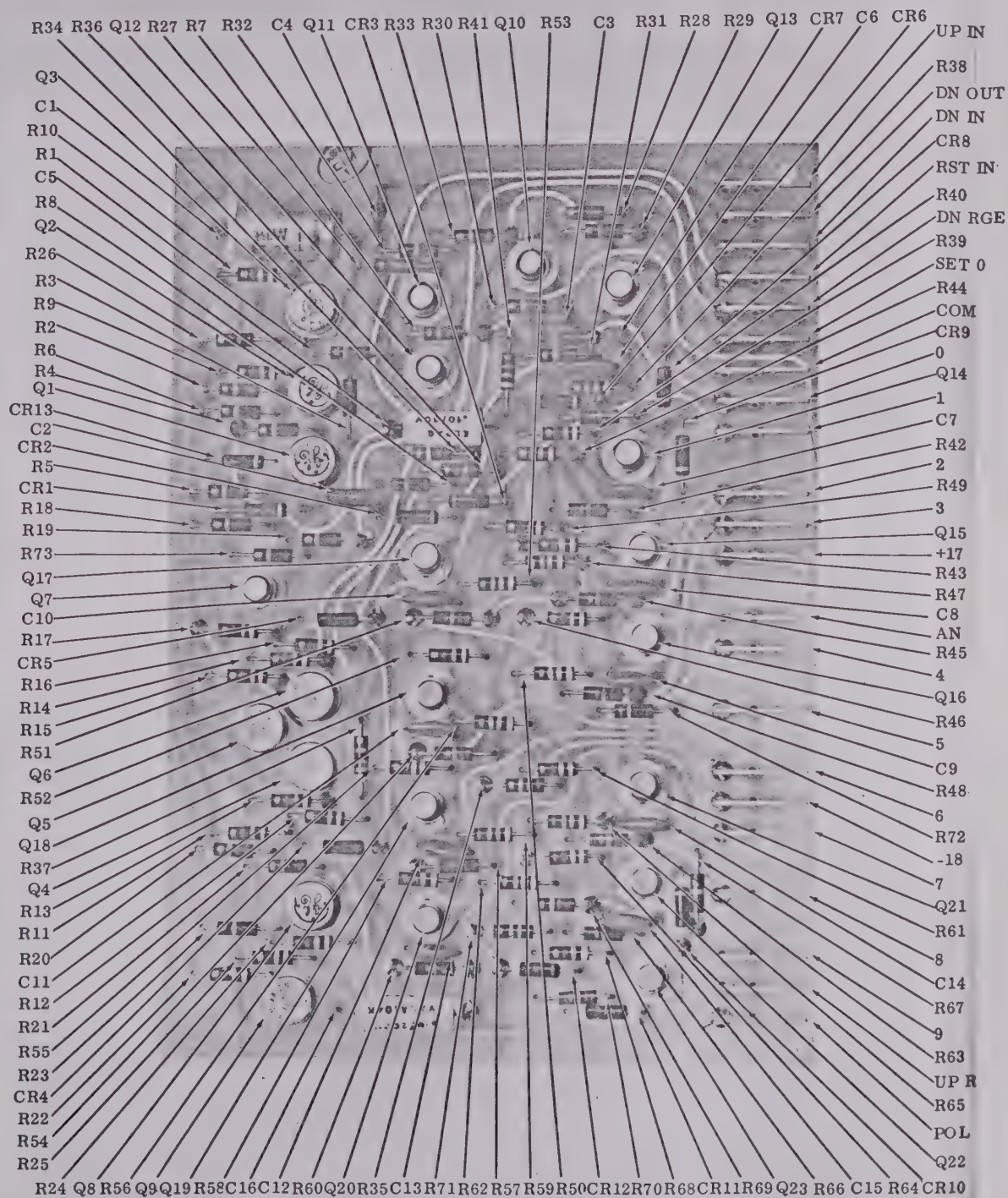


Figure 6-8. 10K Decade

RANGE AND POLARITY

ASSEMBLY 90-6113

PARTS LIST

ASSEMBLY: Range and Polarity

SCHEMATIC NO. 90-0813

CIMRON PART NO. 90-6113

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITOR						
C1301, C1302	1uf	MET PAP	50V 10%	12406	VX5A105K	1-57317
C1303	5uf	MET PAP	100V 20%	12406	VX1A505	1-57313
C1304	5uf	MET PAP	50V	14655	NLW 5-50	1-57255
C1305	1.8nf	CER DISC	1000V 10%	71590	DD-182	1-57503
C1306	0.47uf	MET MY	50V 10%	12406	VX5A474K	1-57318
C1307	1.8nf	CER DISC	1000V 10%	71590	DD-182	1-57503
C1308	5nf	CER DISC	50V	71590	CK-502	1-57512
C1309, C1310	10nf	CER DISC	50V 10%	71590	CK-103	1-57513
C1311	0.1uf	MET PAP	50V 10%	12406	VX5A104K	1-57321
RESISTOR						
R1301	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R1302	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1303	470Ω	COMP	1/4W 5%	01121	CB-4715	7-41239
R1304	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R1305	330KΩ	COMP	1/4W 5%	01121	CB-3345	7-41273
R1306	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1307	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1308	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R1309	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R1310	3.3KΩ	COMP	1/4W 5%	01121	CB-3325	7-41249
R1311	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R1312	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R1313, R1314	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1315, R1316	2.7KΩ	COMP	1/4W 5%	01121	CB-2725	7-41248
R1317	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R1318, R1319	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1320, R1321	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1322	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R1323	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R1324	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1325, R1326	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1327	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R1328	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R1329	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1330	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1331	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R1332	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267

PARTS LIST

ASSEMBLY: Range and Polarity

SCHEMATIC NO. 90-0813

CIMRON PART NO. 90-6113

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R1333	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1334	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R1335	56KΩ	COMP	1/4W 5%	01121	CB-5635	7-41264
R1336	220KΩ	COMP	1/4W 5%	01121	CB-2245	7-41271
R1337	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1338	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R1339	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1340	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R1341	270KΩ	COMP	1/4W 5%	01121	CB-2745	7-41272
R1342	1KΩ	COMP	1/2W 5%	01121	EB-1025	7-41043
R1343	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R1344	270KΩ	COMP	1/4W 5%	01121	CB-2745	7-41272
R1345	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R1346, R1347	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1348	120KΩ	COMP	1/4W 5%	01121	CB-1245	7-41268
R1349	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R1350	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R1351	1MΩ	COMP	1/4W 5%	01121	CB-1055	7-41279
R1352	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R1353	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R1354	120KΩ	COMP	1/4W 5%	01121	CB-1245	7-41268
R1355	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R1356	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231
R1357	1KΩ	COMP	1/2W 5%	01121	EB-1025	7-41043
R1358	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R1359	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255

SEMICONDUCTOR

CR1301 - CR1308	*CD-61 DIODE	15318	7-95511
CR1309	1N714A ZENER DIODE	JEDEC 1N714A	7-95630
CR1310 - CR1319	*CD-61 DIODE	15318	7-95511
CR1320, CR1321	**CD-62 DIODE	15318	7-95507
CR1322 - CR1331	*CD-61 DIODE	15318	7-95511

REED

S1301		95348	MR-306-8	7-38216
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COIL

L1301	REED SWITCH ACTUATOR	15318	50-0501-1
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PARTS LIST

ASSEMBLY: Range and Polarity

SCHEMATIC NO. 90-0813

CIMRON PART NO. 90-6113

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>TRANSISTOR</u>						
Q1301				JEDEC	2N2647	9-04400
Q1302 - Q1304		***CT-20		15318		9-04701
Q1305				JEDEC	2N1304	9-04500
Q1306				JEDEC	2N404A	9-04609
Q1307 - Q1310		***CT-20		15318		9-04701
Q1311				JEDEC	2N3440	9-04801
Q1312				JEDEC	2N3567	9-04719
Q1313		***CT-20		15318		9-04701
Q1314		UNIJUNCTION		JEDEC	2N4852	9-04402
Q1315				JEDEC	2N3567	9-04719
Q1316				JEDEC	2N3440	9-04801

MISCELLANEOUS

ETCHED BOARD, RANGE AND

POLARITY

15318

90-7113-3

SHIELD ASSEMBLY, RANGE AND

POLARITY

15318

80-2000-3

NOTE*CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON**CD-62, $I_f = 1V$ greater than 100 ma, $I_r = 300V$ less than 6 ua, SILICON

***CT-20 = 2N697

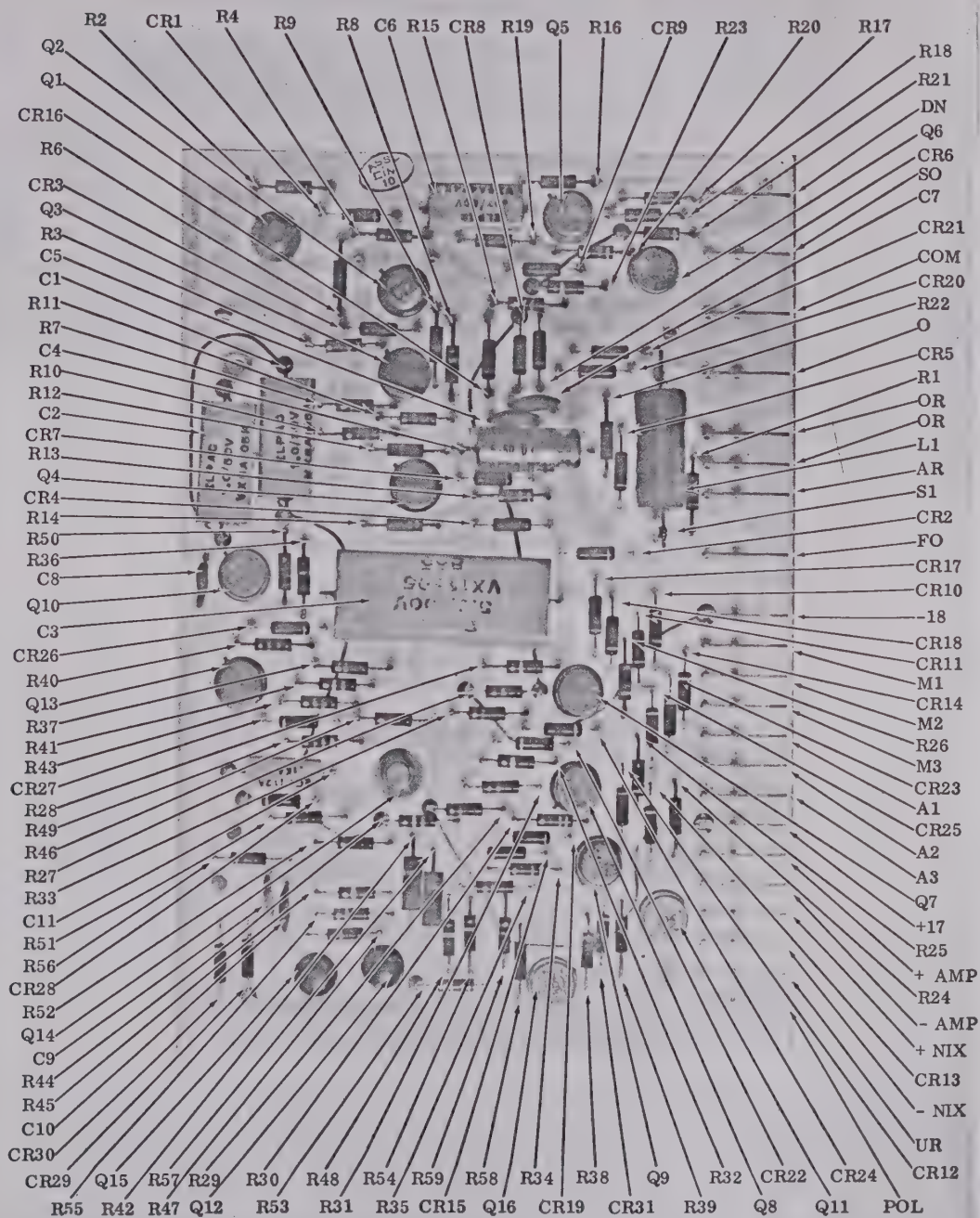


Figure 6-9. Range and Polarity.

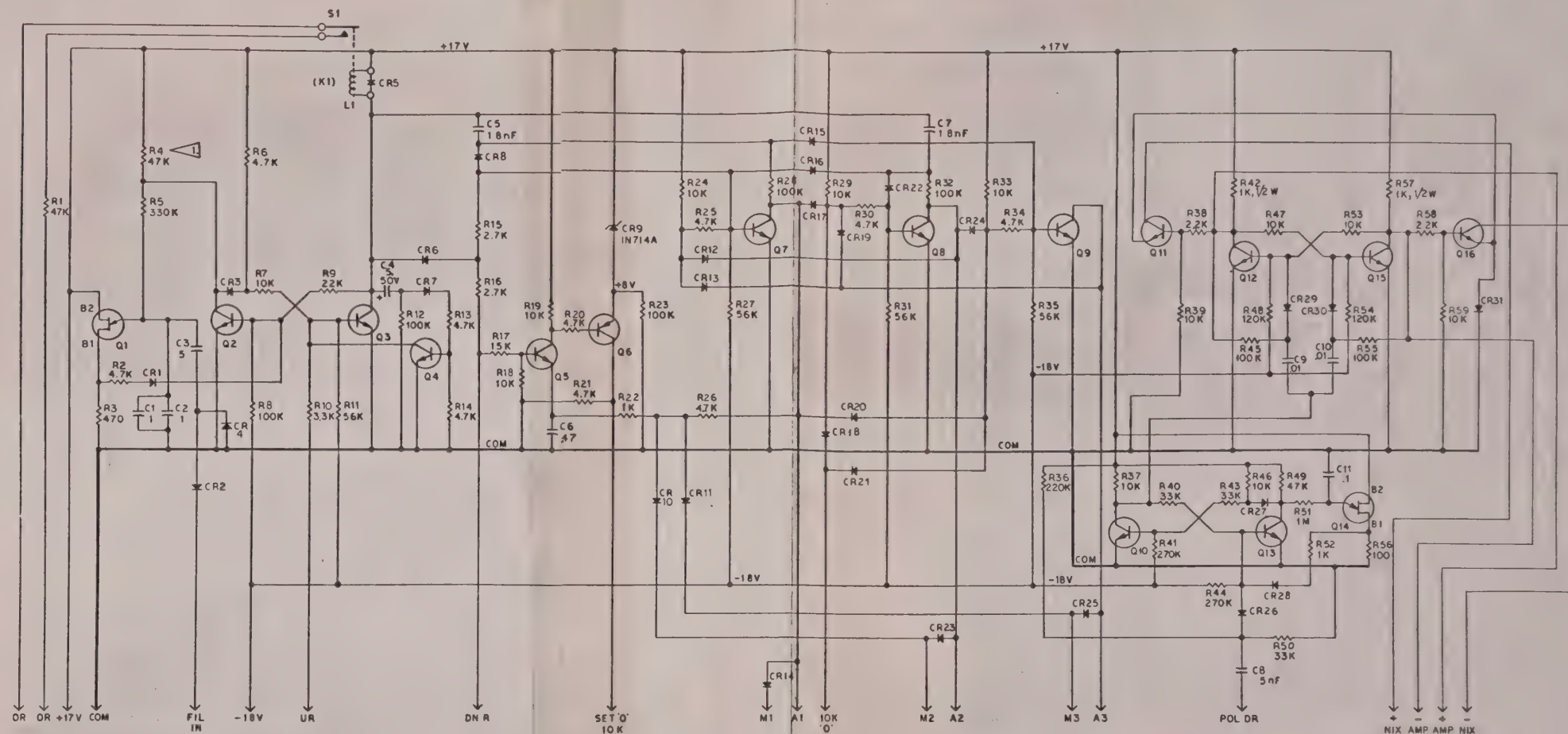
REFERENCE

ASSEMBLY 90-6114

ASSEMBLY: Reference SCHEMATIC NO. 90-0814 CIMRON PART NO. 90-6114

NOTE:

*Selected Value



NOTES

1. PARTIAL REFERENCE DESIGNATIONS SHOWN. ALL NUMBERS ARE IN SERIES 1301 AND ON. FOR COMPLETE DESIGNATION ADD 1300 TO DIGITS SHOWN. EXAMPLE: R2 IS R1302
2. ALL RESISTORS ARE 1/4W & ±5% TOLERANCE, UNLESS NOTED OTHERWISE.
3. ALL CAPACITORS ARE IN μF UNLESS NOTED OTHERWISE.
4. CR1 THRU CR8, CR10 THRU CR19 & CR22 THRU CR31 ARE CD-61
CR20 & CR21 ARE CD-62
5. Q1 & Q14 ARE 2N4852; Q2, Q3, Q4 & Q7 THRU Q10 & Q13 ARE CT-20
Q5 IS 2N1304; Q6 IS 2N4044; Q8 & Q16 ARE 2N3440; Q12 & Q15 ARE 2N3567
6. LAST NO. USED: C18; CR31; Q16; R59 | NO. NOT USED: NONE

Schematic 10. Range and Polarity.

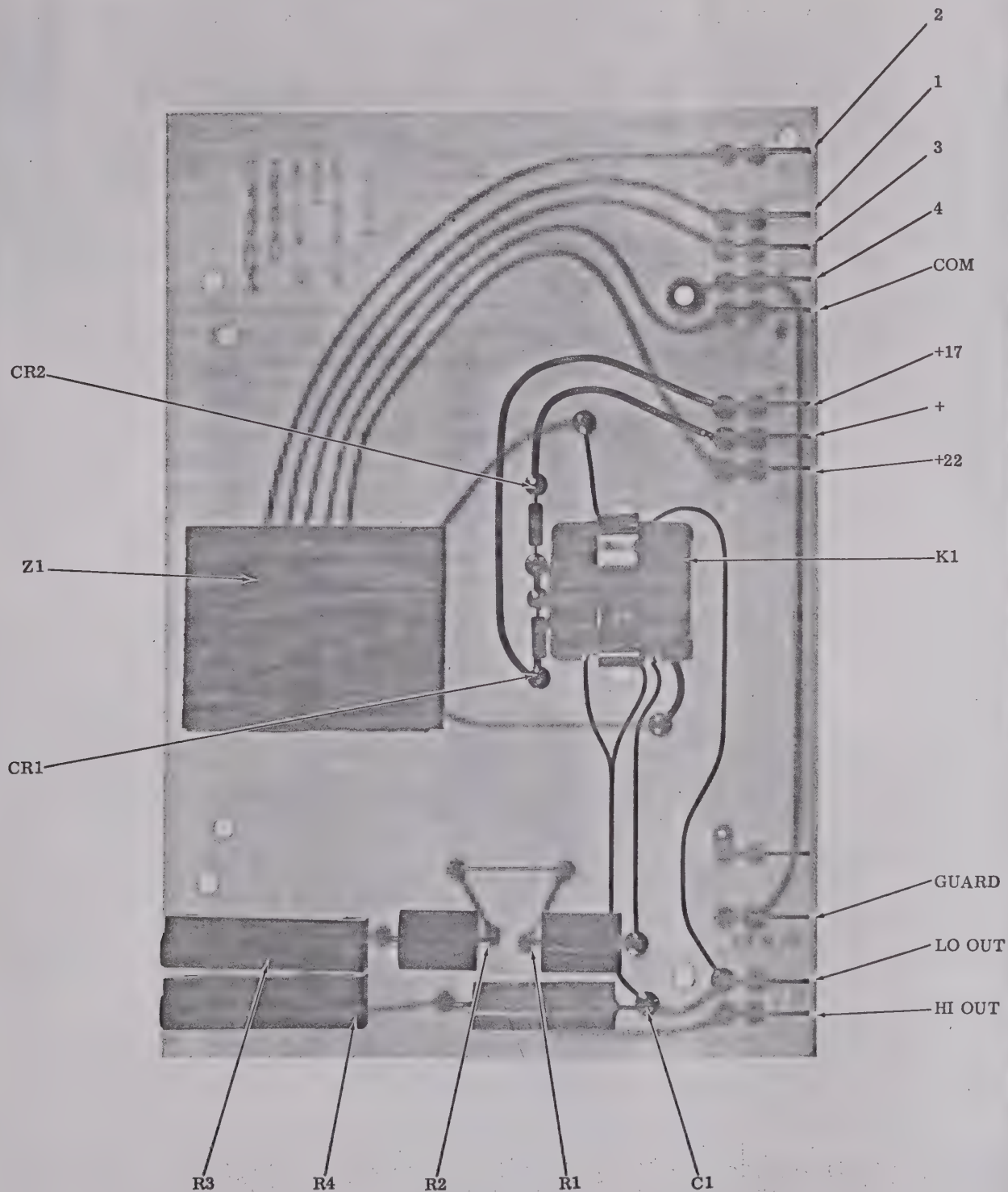


Figure 6-10. Reference.

10K POTENTIOMETER

ASSEMBLY 90-6112

PARTS LIST

ASSEMBLY: 10K's Potentiometer

SCHEMATIC NO. 90-0709

CIMRON PART NO. 90-6112

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	

RESISTOR

R901 - R911	10K Ω	WW	0.01%	05347	305A	5-40012
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SEMICONDUCTOR

CR901 - CR910	**CD-61 DIODE	15318	7-95511
CR911 - CR920	***CD-62 DIODE	15318	7-95507

MISCELLANEOUS

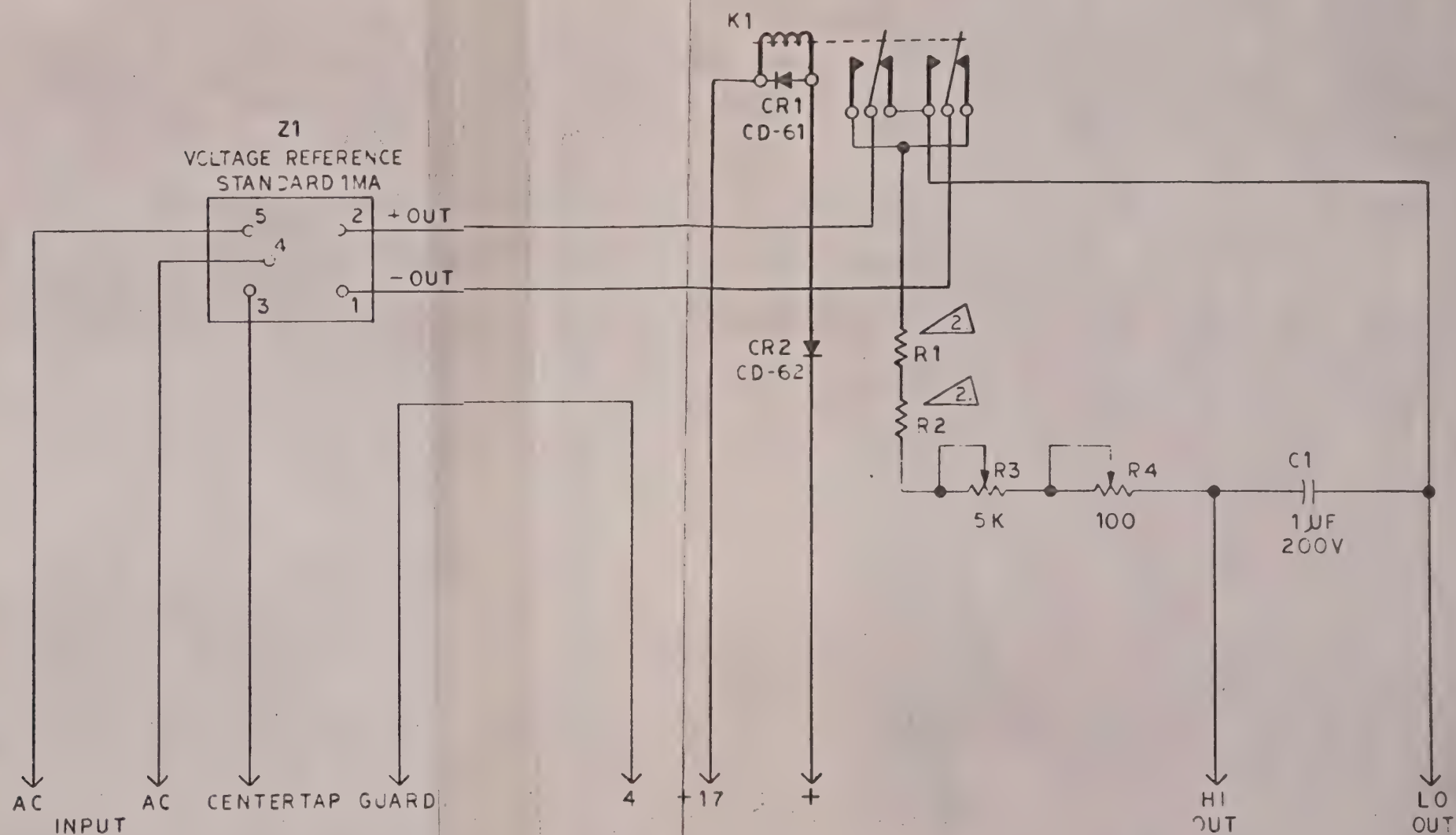
	SHIELD ASSEMBLY	15318	90-3049-1
	ETCHED BOARD, 10K POT A	15318	90-7208-1
	ETCHED BOARD, 10K POT B		90-7109-1
K901-K920	LOW THERMAL SWITCH	15318	90-0513

NOTE

*These resistors are ratio-matched to 0.001% and must be replaced as one unit under part number 5-40012.

**CD-61, I_f = 1V greater than 100 ma, I_r = 75V less than 1 ua, SILICON

***CD-62, I_f = 1V greater than 100 ma, I_r = 300V less than 6 ua, SILICON



NOTES

1. PARTIAL REFERENCE DESIGNATIONS SHOWN, FOR COMPLETE DESIGNATOR ADD 1400, EXAMPLE: R1 IS R1401.

2. FACTORY SELECTED VALUE.

3. LAST NO. USED: C1, CR2, R4, Z1, K1. | NO'S NOT USED: NONE

Schematic 11. Reference.

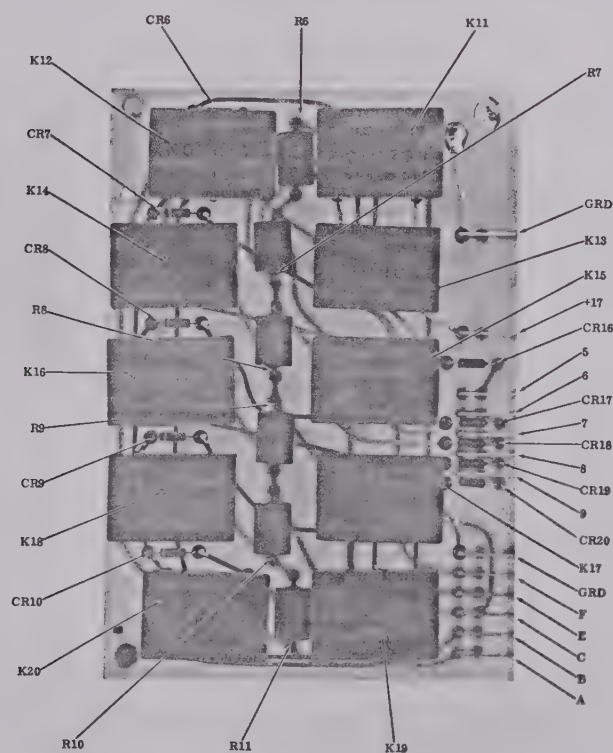
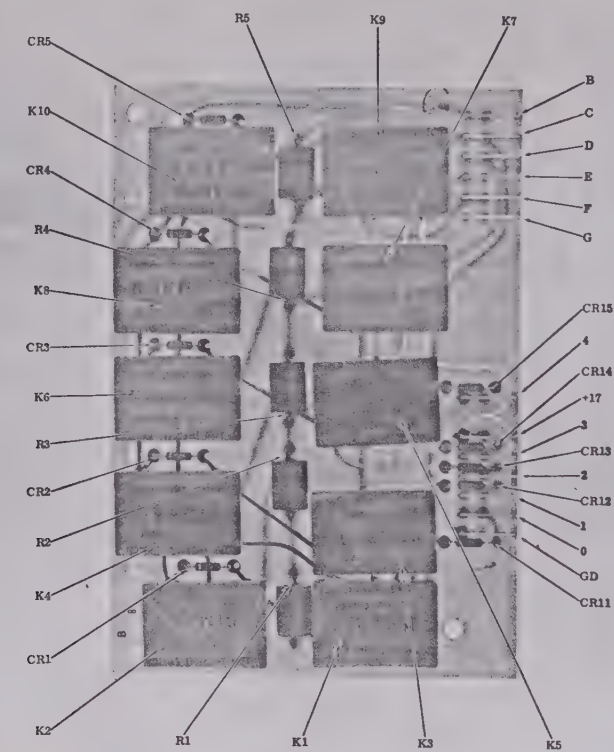


Figure 6-11. 10K Pot.

THOUSANDS POTENTIOMETER

ASSEMBLY 90-6107

PARTS LIST

ASSEMBLY: 1000's Potentiometer

SCHEMATIC NO. 90-0708

CIMRON PART NO. 90-6107

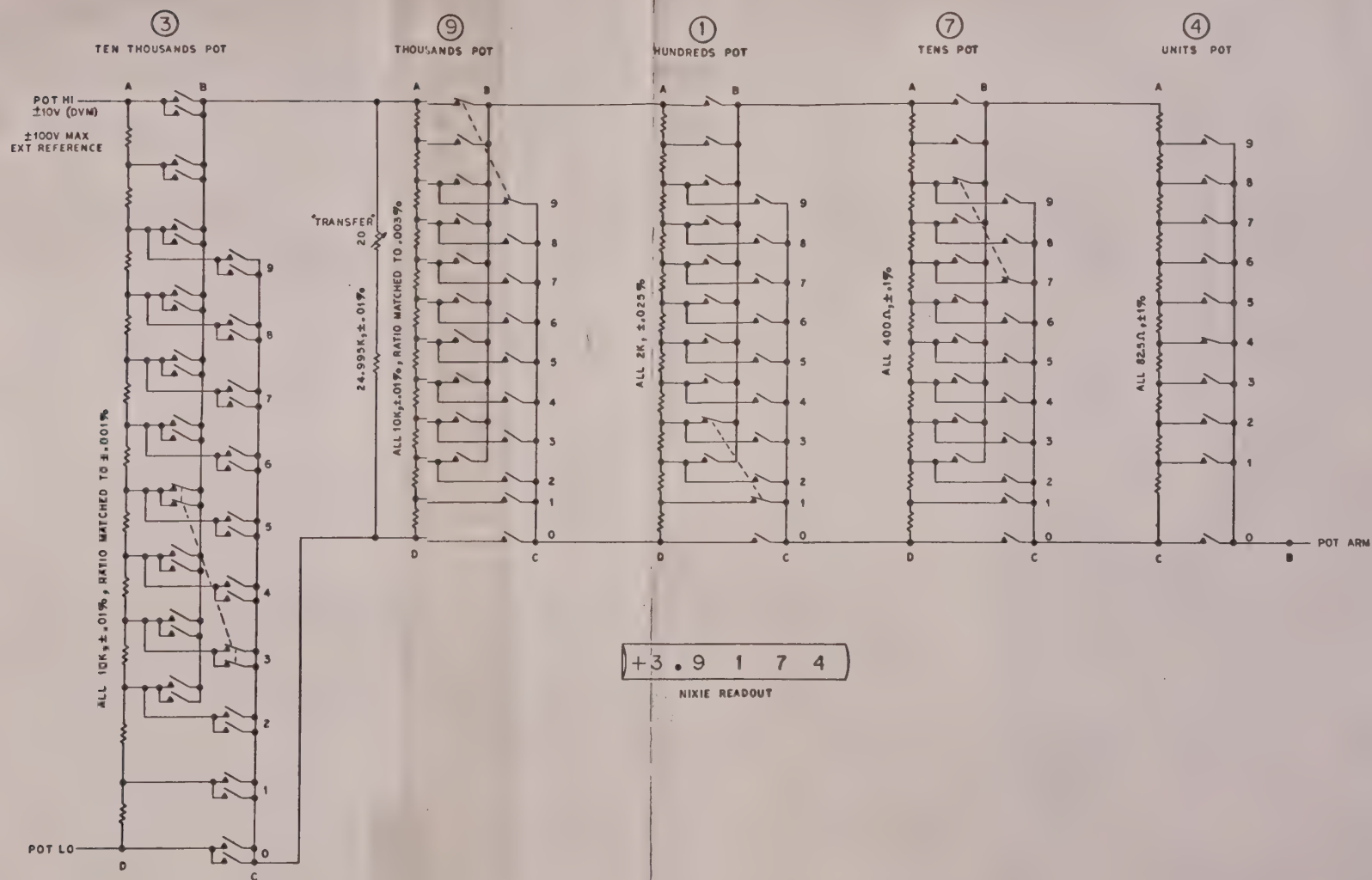
SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R801	24.995KΩ	WW	0.01%	15318		5-40013
R802	20Ω	VAR TRIM WW	1W	09145	114-200	7-54214
R803 - R813	10KΩ	WW	0.01%	15318		5-40013
<u>SEMICONDUCTOR</u>						
CR801 - CR810		**CD-61 DIODE		15318		7-95511
CR811 - CR820		***CD-62 DIODE		15318		7-95507
<u>MISCELLANEOUS</u>						
		SHIELD ASSEMBLY, 1000's POT		15318		80-2000-1
		ETCHED BOARD, 1000's POT		15318		90-7107-1
K801-K810		LOW THERMAL SWITCH		15318		90-0513

NOTE

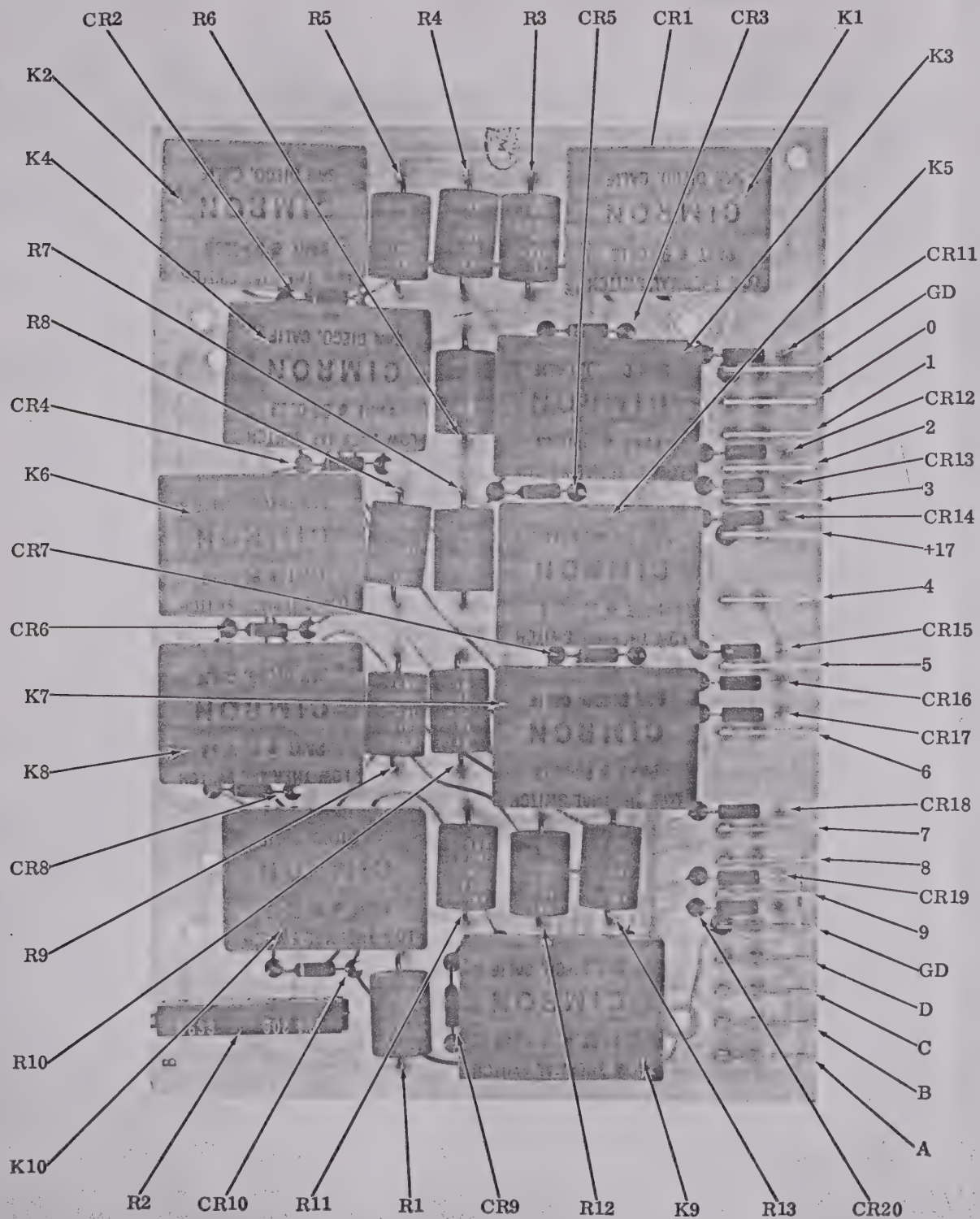
*These resistors are ratio-matched to 0.003% and must be replaced as one unit under part number 5-40013.

**CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON

***CD-62, $I_f = 1V$ greater than 100 ma, $I_r = 300V$ less than 6 ua, SILICON



Schematic #12. Potentiometer Block Diagram.



HUNDREDS POTENTIOMETER

ASSEMBLY 90-6106

PARTS LIST

ASSEMBLY: 100's Potentiometer

SCHEMATIC NO. 90-0707

CIMRON PART NO. 90-6106

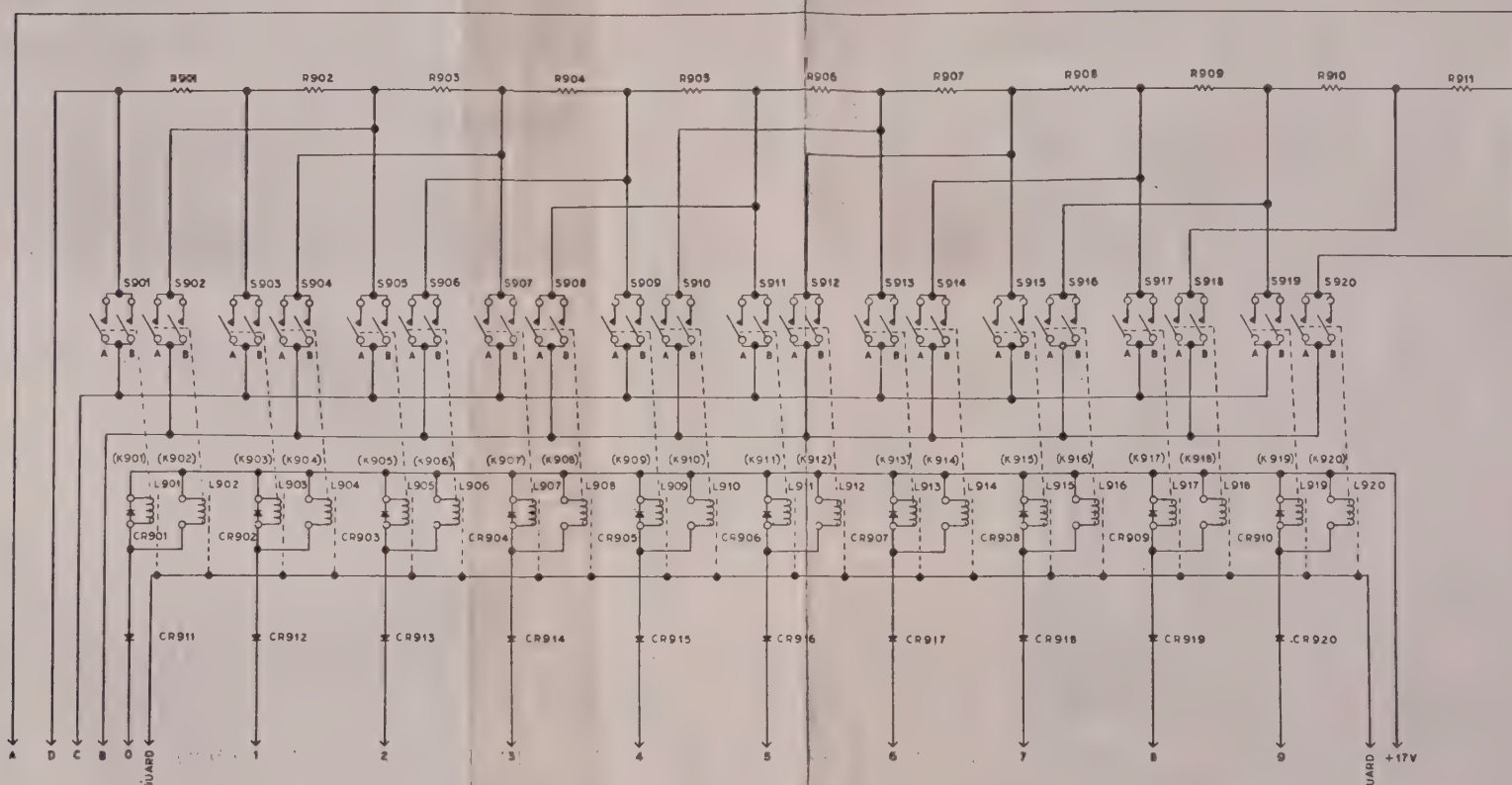
SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R701 - R711	2K Ω	WW	0.025%	15318		5-40014
<u>SEMICONDUCTOR</u>						
CR701 - CR710		**CD-61 DIODE		15318		7-95511
CR711 - CR720		***CD-62 DIODE		15318		7-95507
<u>MISCELLANEOUS</u>						
		SHIELD ASSEMBLY, 100's POT		15318		80-2000-3
		ETCHED BOARD, 100's POT		15318		90-7106-1
K701-K710		LOW THERMAL SWITCH		15318		90-0513

NOTE

*These resistors must be replaced as one unit under part number 5-40014.

**CD-61, I_f = 1V greater than 100 ma, I_r = 75V less than 1 ua, SILICON

***CD-62, I_f = 1V greater than 100 ma, I_r = 300V less than 6 ua, SILICON

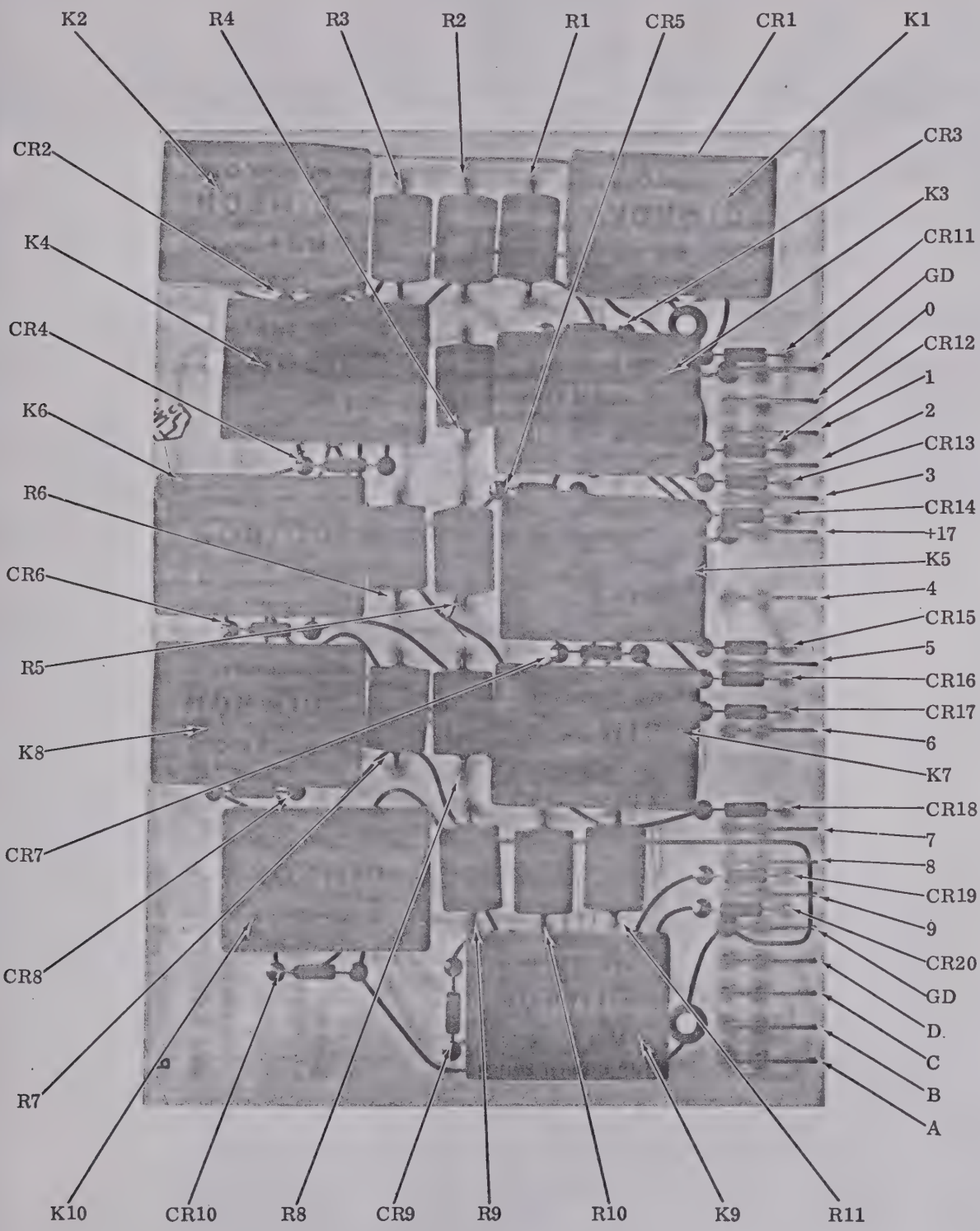


NOTES ◇

1. UNLESS OTHERWISE NOTED RESISTORS ARE 10K, 1/4W, & ±.01% TOLERANCE, MATCHED TO .001%.
2. CR901 THRU CR910 ARE CD-61; CR911 THRU CR920 ARE CD-62.

CAUTION IN ORDER TO ASSURE LOW LEAKAGE USE CLEAN NYLON GLOVES WHEN HANDLING THIS BOARD ASSY.

Schematic 13. 10K Pot.



TENS POTENTIOMETER

ASSEMBLY 90-6105

PARTS LIST

ASSEMBLY: 10's Potentiometer

SCHEMATIC NO. 90-0706

CIMRON PART NO. 90-6105

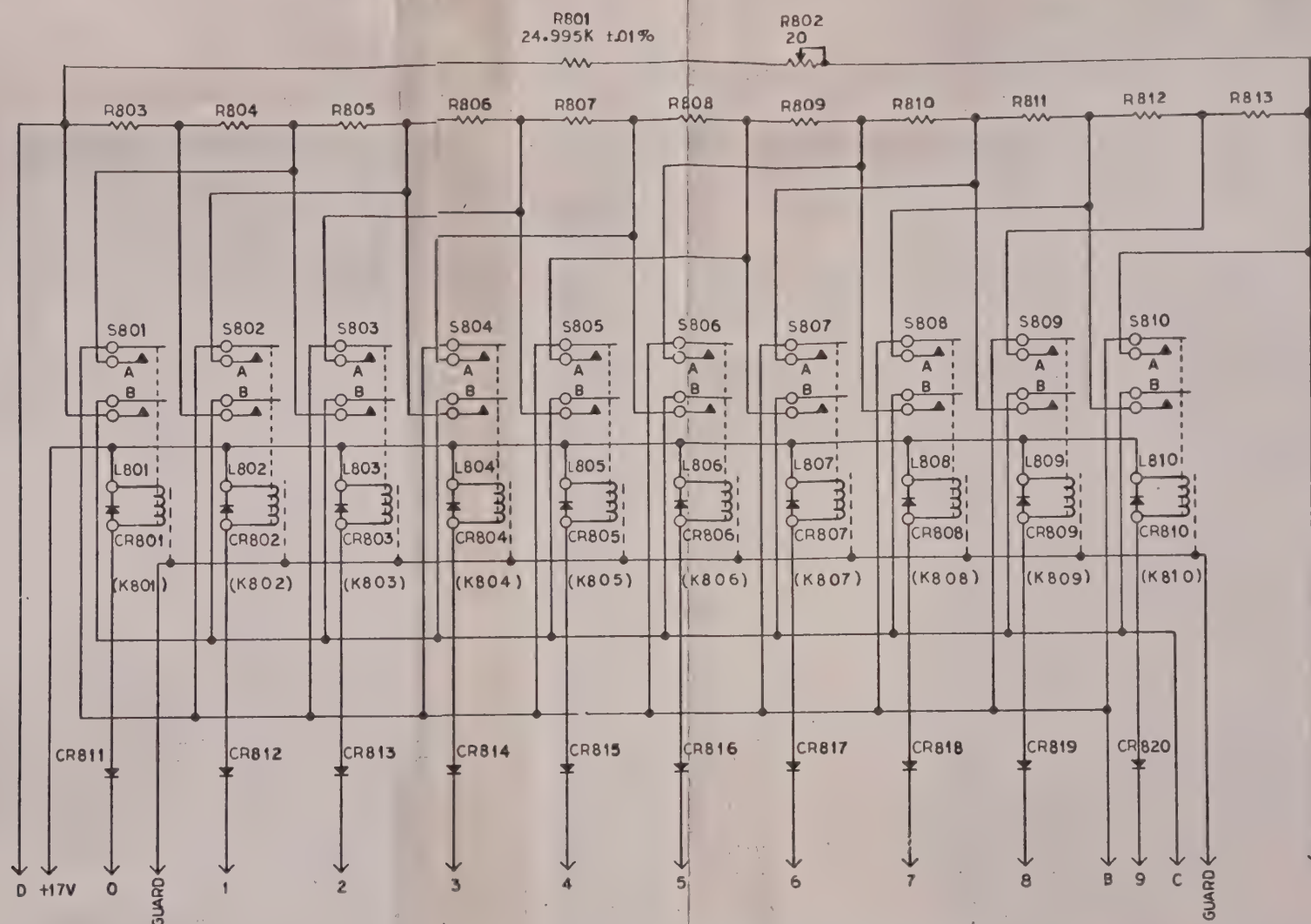
SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R601-R611	400Ω	MET FILM	1/4W 0.1%	15318		5-40015
<u>SEMICONDUCTOR</u>						
CR601 - CR610		**CD-61 DIODE		15318		7-95511
CR611 - CR620		***CD-62 DIODE		15318		7-95507
<u>MISCELLANEOUS</u>						
		SHIELD ASSEMBLY, 10's POT		15318		80-2000-1
		ETCHED BOARD, 10's POT		15318		90-7105-1
K601-K610		LOW THERMAL SWITCH		15318		90-0513

NOTE

*These resistors must be replaced as one unit under part number 5-40015.

**CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON

***CD-62, $I_f = 1V$ greater than 100 ma, $I_r = 300V$ less than 6 ua, SILICON



CAUTION IN ORDER TO
ASSURE LOW LEAKAGE USE
CLEAN NYLON GLOVES WHEN
HANDLING THIS BOARD ASSY

NOTES

1. UNLESS OTHERWISE NOTED RESISTORS ARE 10K Ω , ± 0.1 TOLERANCE.
2. CR801 THRU CR810 ARE CD-61; CR811 THRU CR820 ARE CD-62.

Schematic 14. 1K Pot.

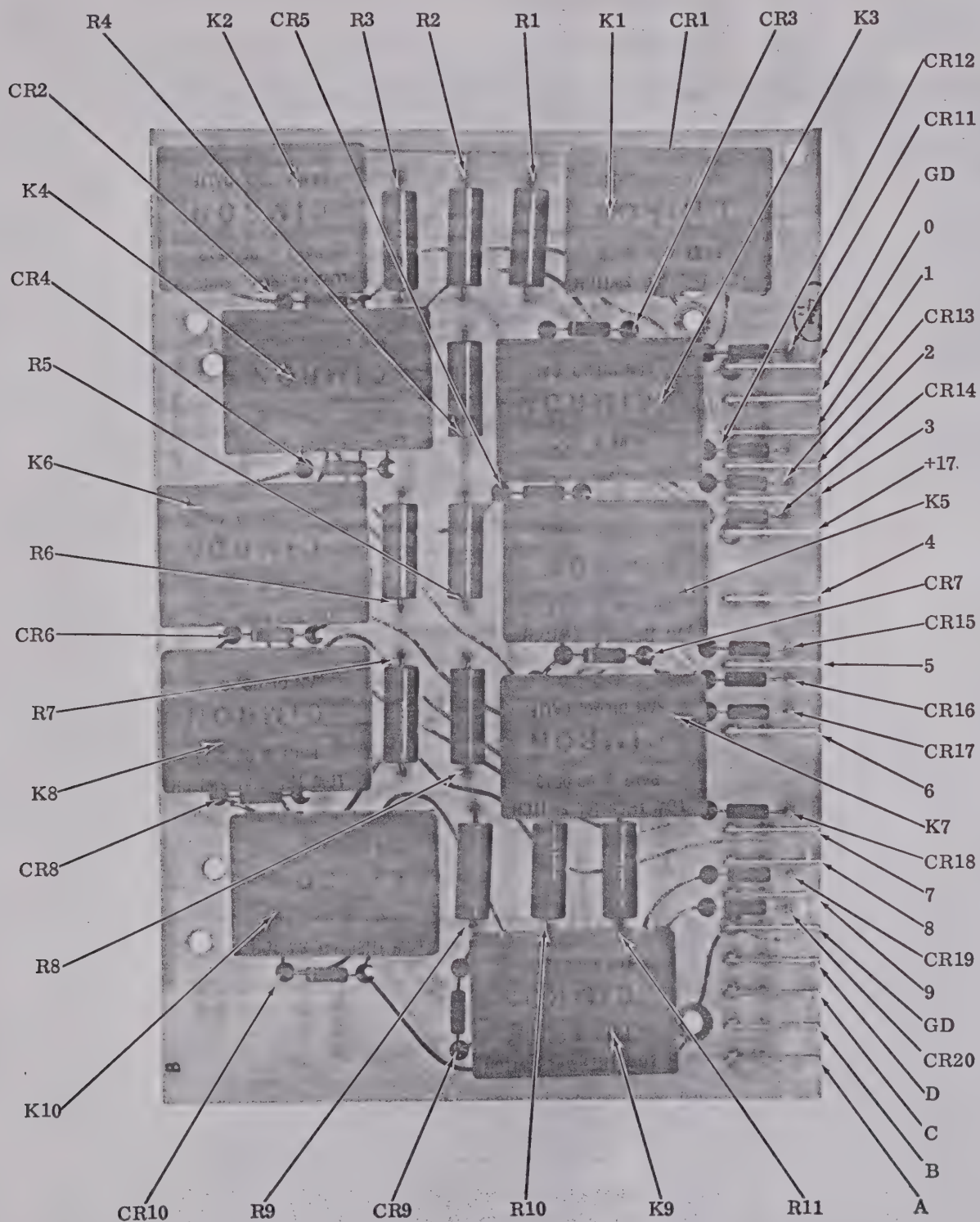


Figure 6-14. 10 Pot.

UNITS POTENTIOMETER

ASSEMBLY 90-6104

PARTS LIST

ASSEMBLY: Units Potentiometer

SCHEMATIC NO. 90-0705

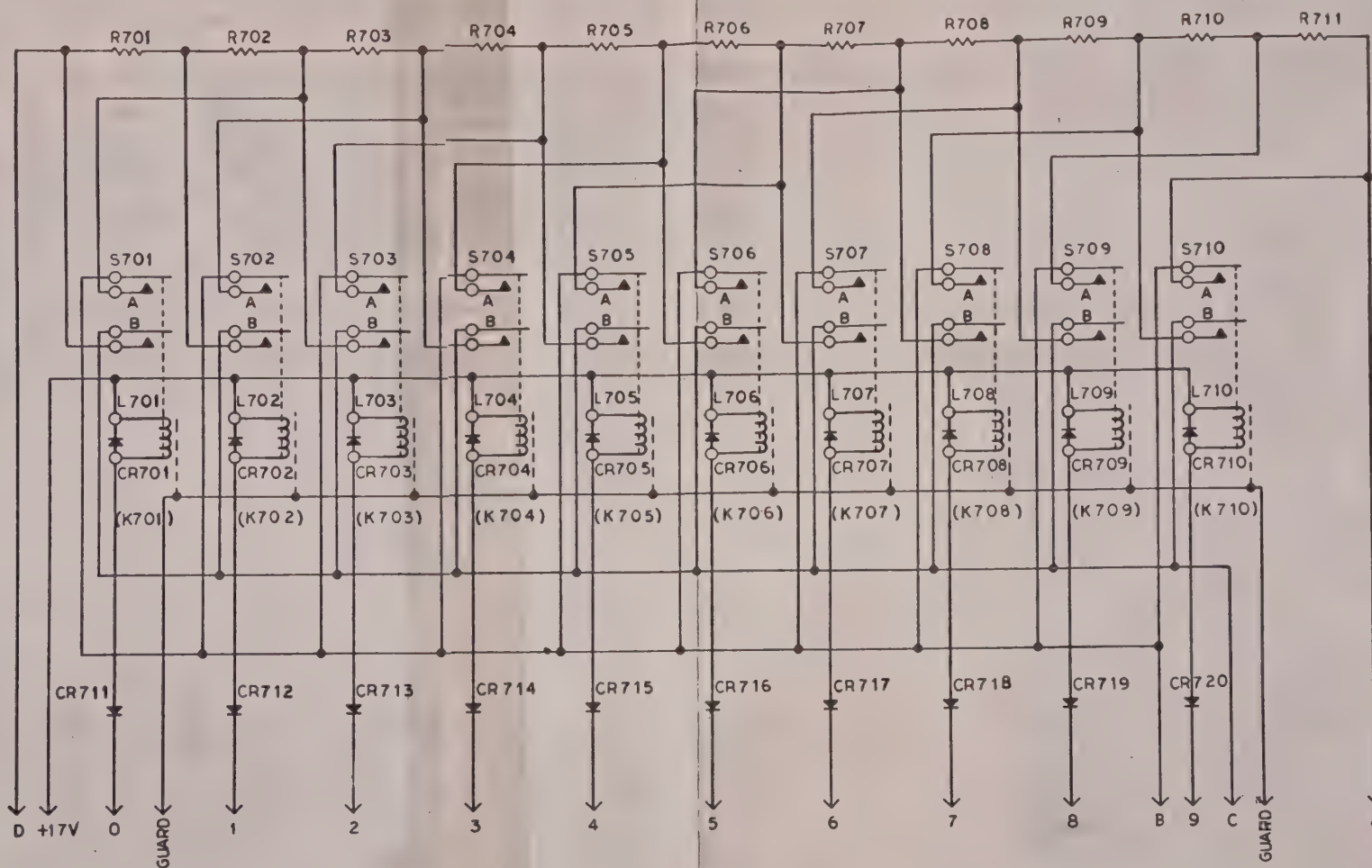
CIMRON PART NO. 90-6104

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R501 - R510	82.5Ω	MET FILM	1/4W 1%	15318		5-40017
<u>SEMICONDUCTOR</u>						
CR501 - CR510		**CD-61 DIODE		15318		7-95511
CR511 - CR520		***CD-62 DIODE		15318		7-95507
<u>MISCELLANEOUS</u>						
		SHIELD ASSEMBLY, UNITS POT		15318		80-2000-3
		ETCHED BOARD, UNITS POT		15318		90-7104-1
K501-K510		LOW THERMAL SWITCH		15318		90-0513

NOTE

*These resistors must be replaced as one unit under part number 5-40017.

CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON*CD-62, $I_f = 1V$ greater than 100 ma, $I_r = 300V$ less than 6 ua, SILICON



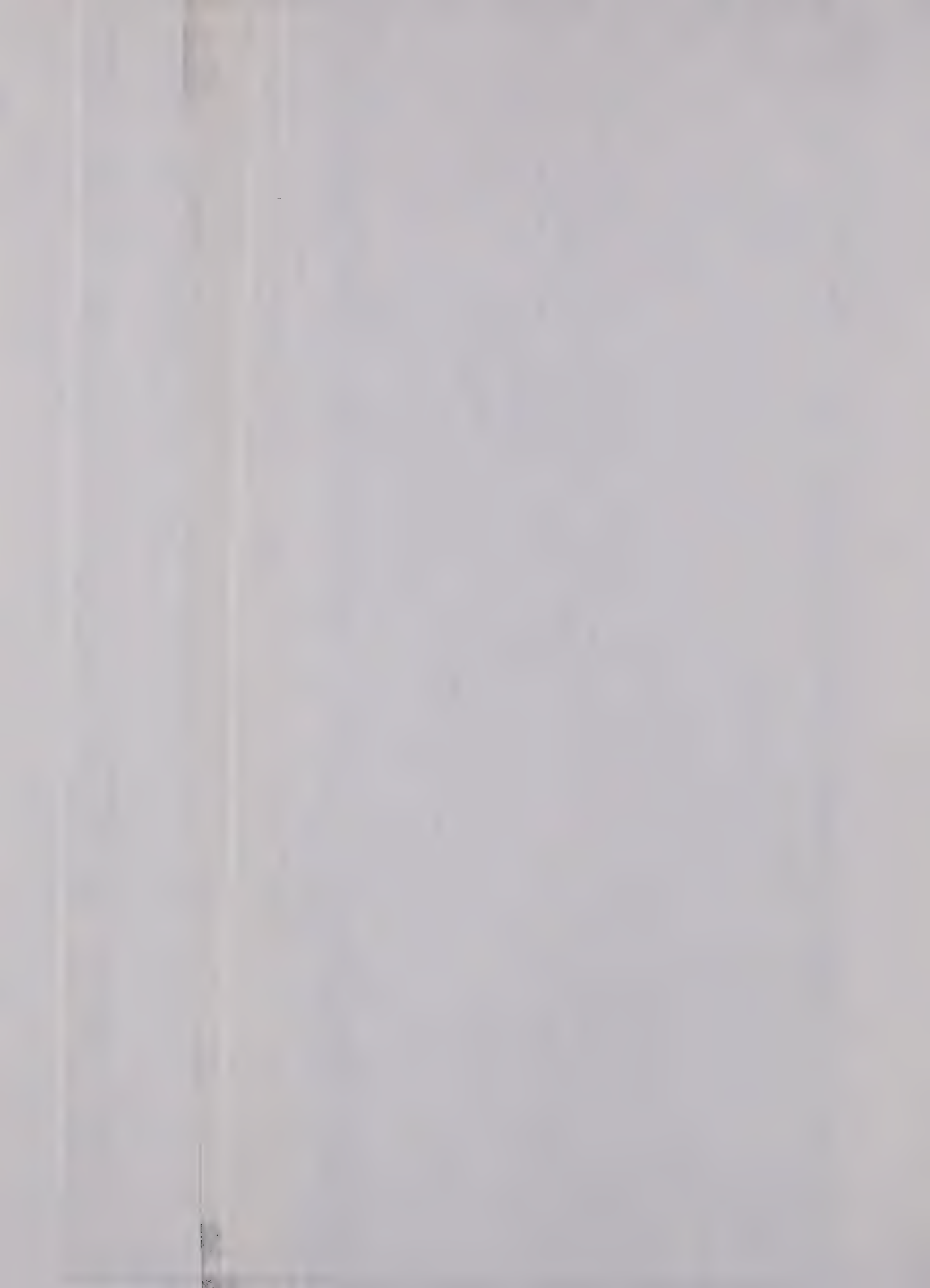
NOTES

1. UNLESS OTHERWISE NOTED RESISTORS ARE $2K \pm 0.25\%$

2. CR701 THRU CR710 ARE CD-61; CR711 THRU CR720 ARE CD-62.

CAUTION IN ORDER TO ASSURE LOW LEAKAGE USE CLEAN NYLON GLOVES WHEN HANDLING THIS BOARD ASSY.

Schematic 15. 100 Pot.



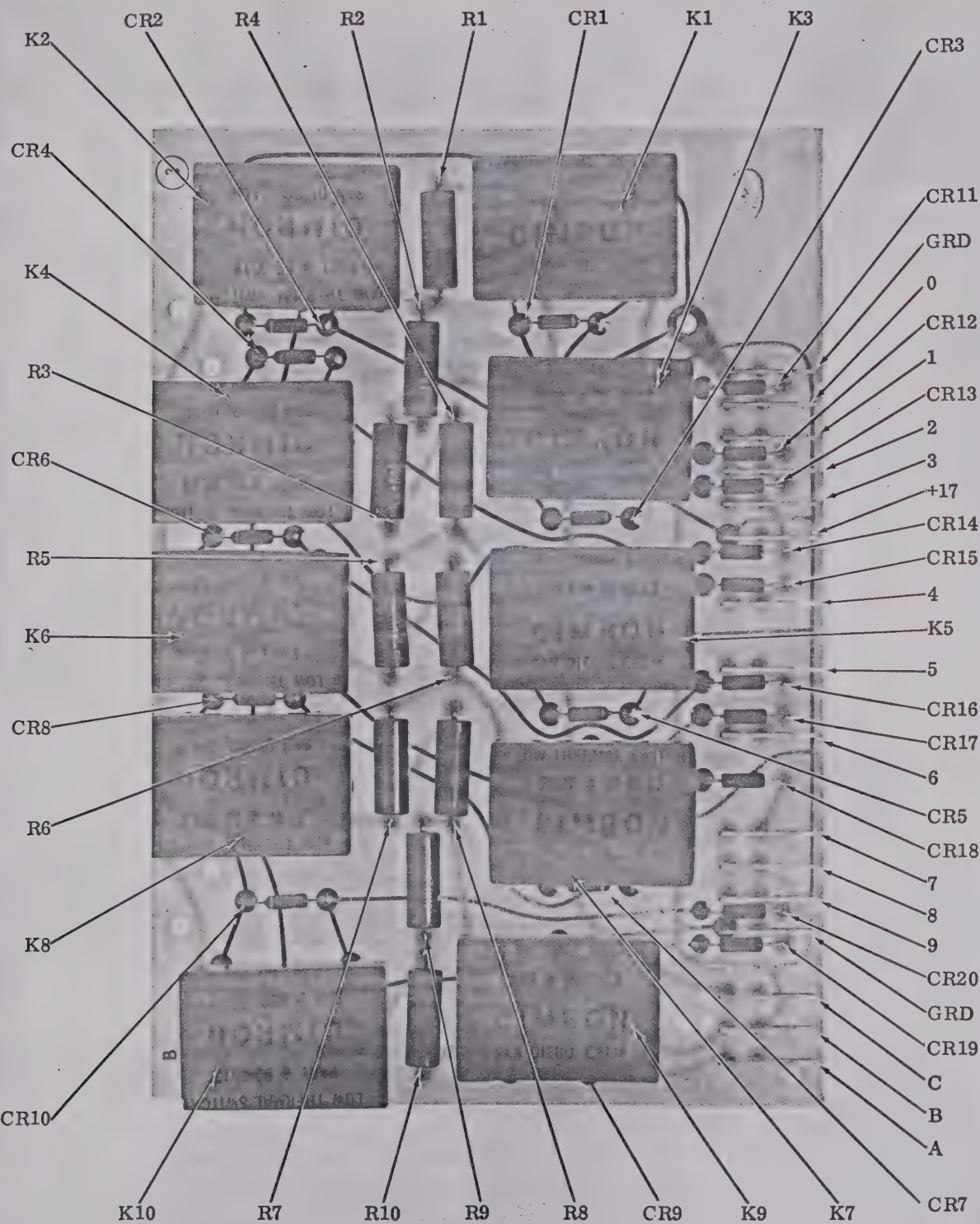


Figure 6-15. Units Pot.

FUNCTION RATIO
ASSEMBLY 90-6074

PARTS LIST

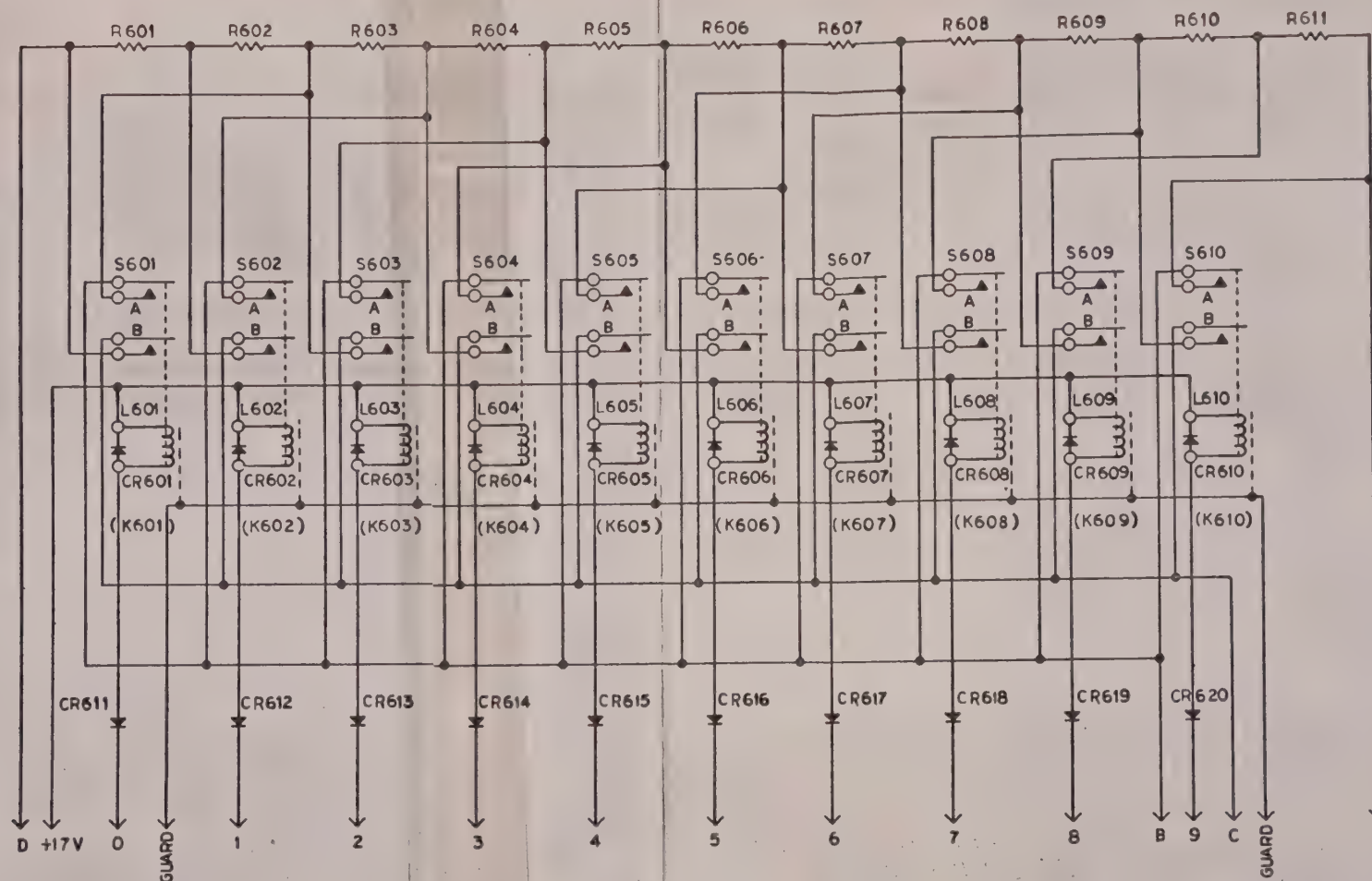
ASSEMBLY: FUNCTION RATIO

SCHEMATIC NO. 90-0774

CIMRON PART NO. 90-6074

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R7401	27KΩ	COMP	1/2W 5%	01121	EB-2735	7-41060
R7402	180Ω	COMP	1/2W 5%	01121	EB-1815	7-41034
<u>SEMICONDUCTOR</u>						
CR7401 - CR7410		**CD-61 DIODE		15318		7-95511
CR7411 - CR7438		**CD-62 DIODE		15318		7-95507
<u>SOLENOID</u>						
K7401, K7402		RELAY PRINTED CIRCUIT 3PDT		21226	12-BW3-G	7-38215
<u>REED</u>						
S7401 - S7405		RELAY MR-306-8		95348	MR-306-8	7-38216
<u>COIL</u>						
L7401 - L7403		REED SWITCH ACTUATOR		15318		80-0501-1
L7404, L7405		REED SWITCH ACTUATOR		15318		50-0501-1
<u>MISCELLANEOUS</u>						
		SHIELD ASSEMBLY, FUNCTION				
		RATIO	15318			80-2000-3
		ETCHED BOARD, FUNCTION RATIO	15318			90-7074-3

NOTE**CD-61, I_f = 1V greater than 100 ma, I_r = 75V less than 1 ua, SILICON**CD-62, I_f = 1V greater than 100 ma, I_r = 300V less than 6 ua, SILICON



NOTES

1. UNLESS OTHERWISE NOTED RESISTORS ARE 400Ω, ±1% TOLERANCE.
2. CR601 THRU CR610 ARE CD-61; CR611 THRU CR620 ARE CD-62.

CAUTION IN ORDER TO ASSURE LOW LEAKAGE USE CLEAN NYLON GLOVES WHEN HANDLING THIS BOARD ASSY

Schematic 16. 10 Pot.





FUNCTION
ASSEMBLY 90-6116

PARTS LIST

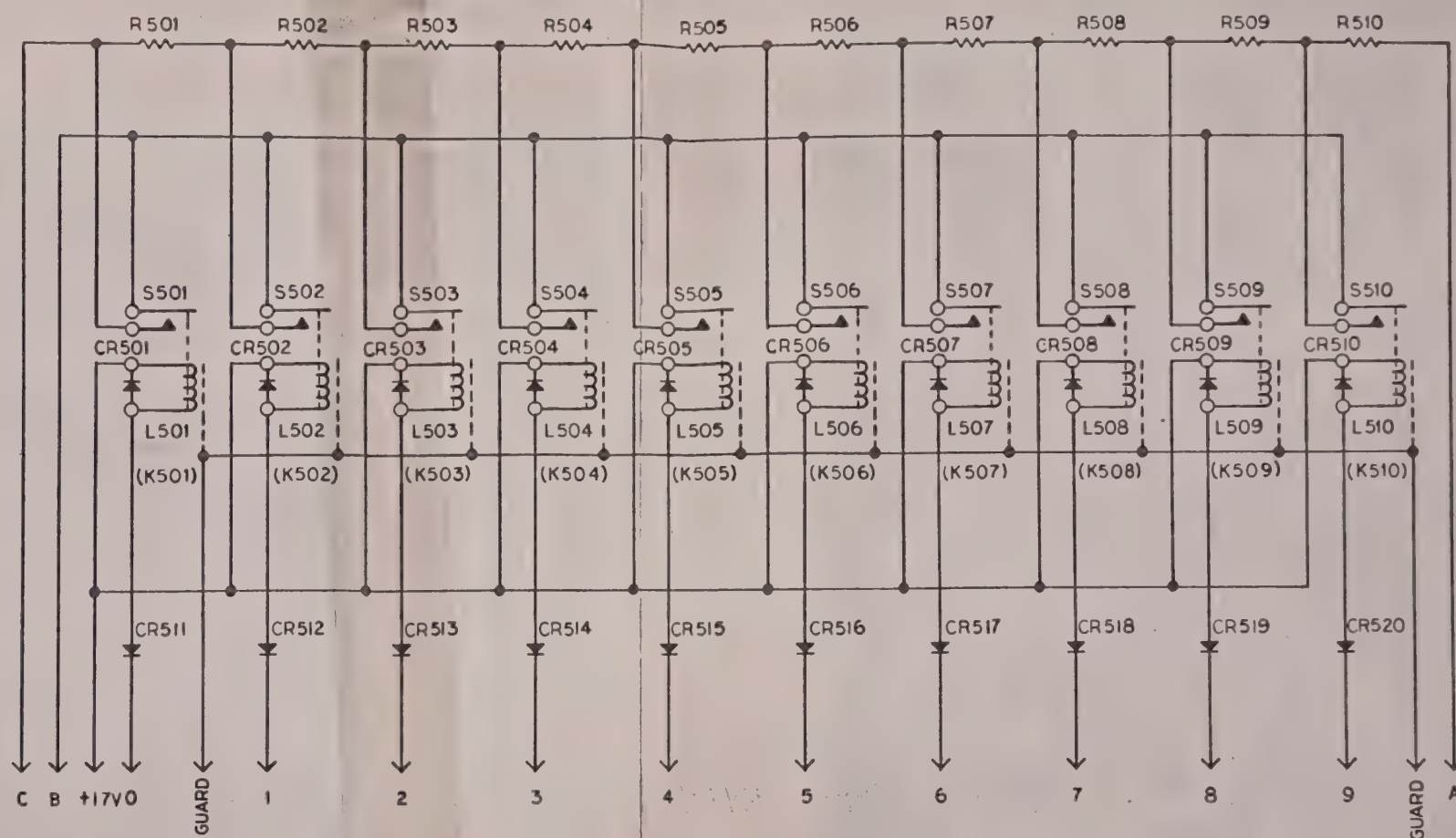
ASSEMBLY: Function

SCHEMATIC NO. 90-0816

CIMRON PART NO. 90-6116

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R1601	27KΩ	COMP	1/2W 5%	01121	EB-2735	7-41060
<u>SEMICONDUCTOR</u>						
CR1601 - CR1617		*CD-62 DIODE		15318		7-95507
<u>MISCELLANEOUS</u>						
K1601 - K1605		COIL REED		15318		50-0501-1
S1601 - S1605		REED RELAY		95348	MR-306-8	7-38216
		SHIELD ASSEMBLY		15318		80-2000-3
		ETCHED BOARD		15318		90-7116-1

NOTE*CD-62, $I_f = 1V$ greater than 100 ma; $I_r = 300V$ less than 6 ua, SILICON

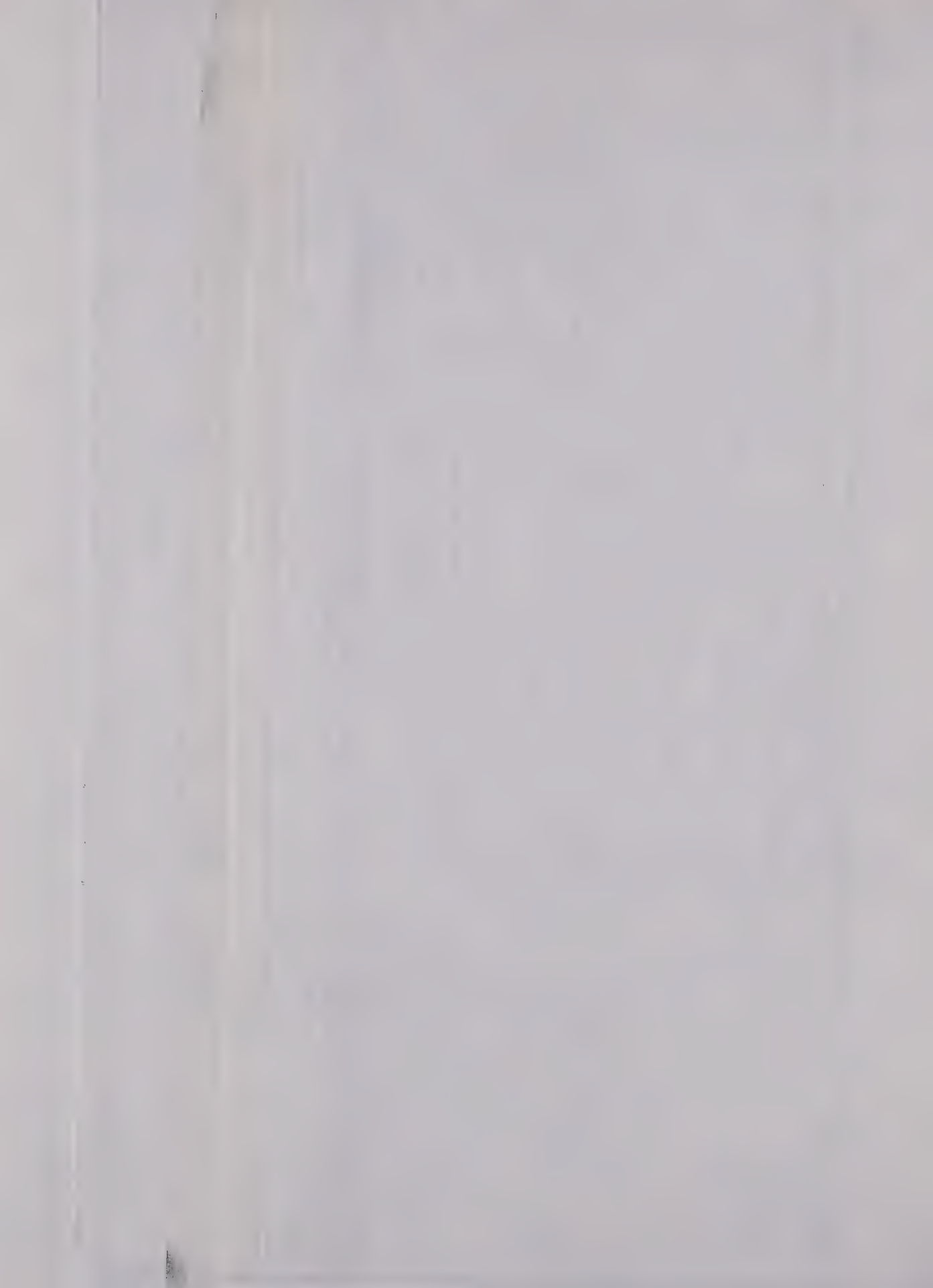


CAUTION IN ORDER TO
ASSURE LOW LEAKAGE USE
CLEAN NYLON GLOVES WHEN
HANDLING THIS BOARD ASSY.

NOTES ◇

1. ALL RESISTORS ARE 82.5Ω
 $\pm 1\%$ TOLERANCE.
2. CR501 THRU CR510 ARE CD-61; CR511 THRU CR520 ARE CD-62.

Schematic 17. Units Pot.



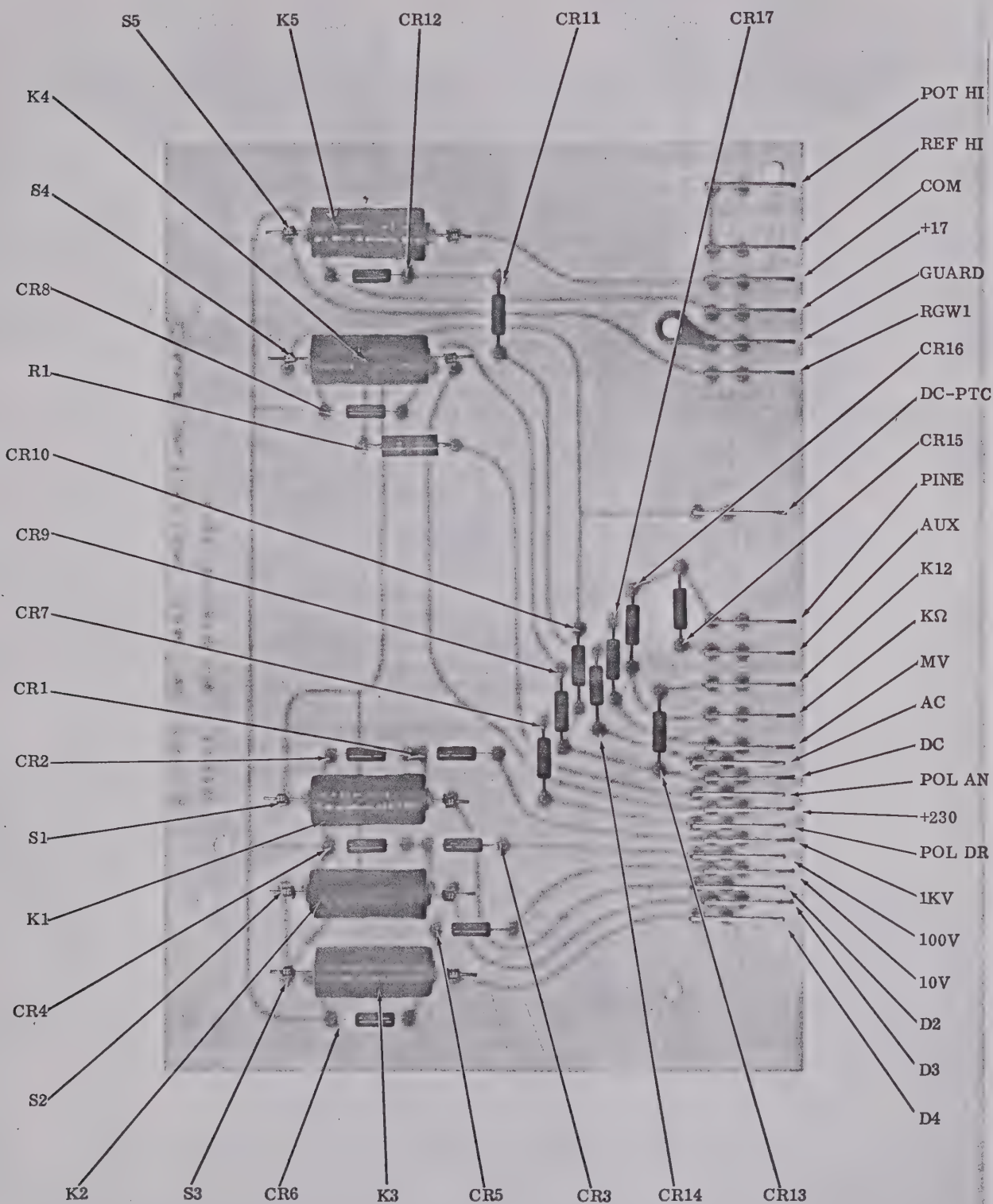


Figure 6-16A. Function.

FUNCTION INDICATOR

SUBASSEMBLY

PARTS LIST

SUBASSEMBLY: Function Indicator SCHEMATIC NO. 90-0736 CIMRON PART NO. 90-6036

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>RESISTOR</u>						
R3601, R3602	47KΩ	COMP	1/4W 5%	01121	CB-4735	7-41263
R3603	470KΩ	COMP	1/4W 5%	01121	CB-4745	7-41275
<u>SEMICONDUCTOR</u>						
CR3601 - CR3603	**CD-62 DIODE			15318		7-95507
<u>MISCELLANEOUS</u>						
DS3601 - DS3604	LAMP, GLOW, NE-2H				NE-2H	5-46501
	MY NEG FUNCTION LEGEND			15318		80-0400-1
	BLOCK READOUT FUNCTION			15318		80-3009-1
	ETCHED BOARD, FUNCTION INDICATOR			15318		90-7036-3
	ETCHED BOARD, INSULATOR			15318		90-7037-1

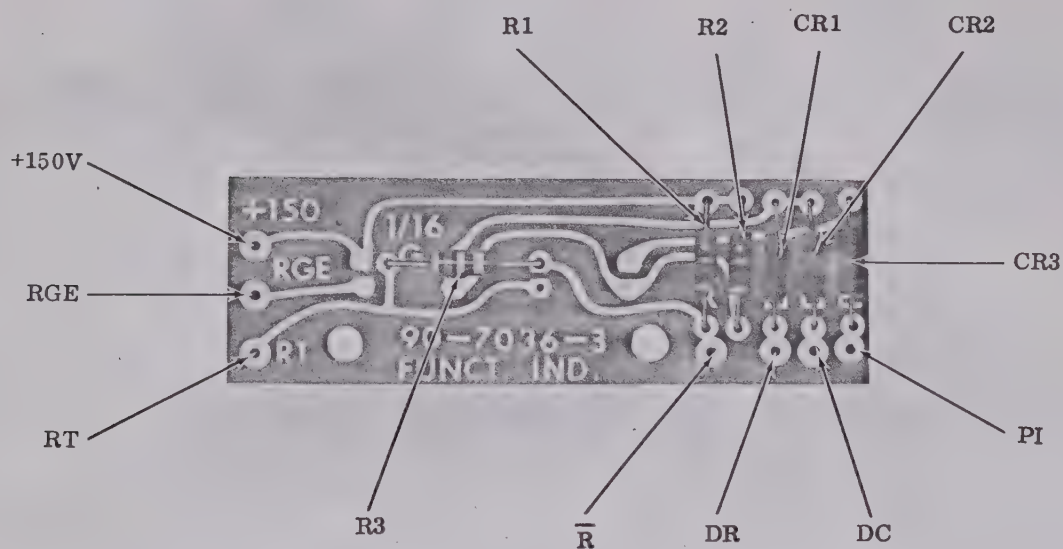
NOTE

**CD-62, I_f = 1V greater than 100 ma, I_r = 300V less than 6 ua, SILICON

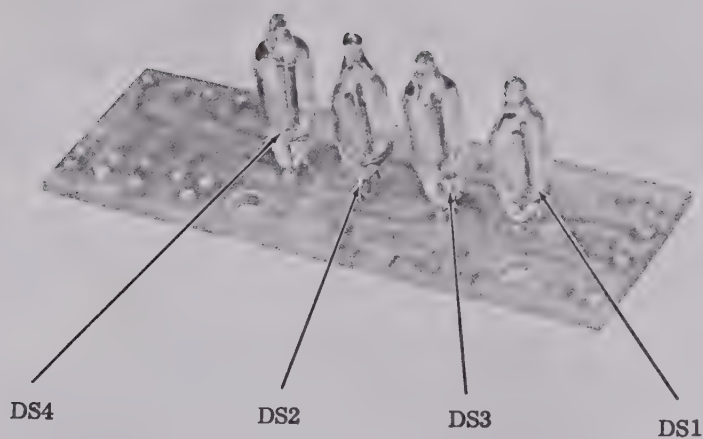


- | TYPE | DESIGNATOR | RATING |
|-------|--------------------|---------------------------------|
| CD 61 | CR7401 THRU CR7410 | <u>100 MA</u>
<u>75 PIV</u> |
| CD 62 | CR7411 THRU CR7435 | <u>100 MA</u>
<u>300 PIV</u> |

18



REAR VIEW



FRONT VIEW

Figure 6-17. Function Indicator.

RANGE DETECTOR

ASSEMBLY 90-6088

PARTS LIST

ASSEMBLY: Range Detector

SCHEMATIC NO. 90-0788

CIMRON PART NO. 90-6088

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITOR						
C8801	10uf	ELECT	25V	14655	NLW 10-25	1-57250
C8802	2.2uf	TANT	20V 10%	56289	150D225X9020A2	1-57108
C8803	.22uf	MET PAP	50V 10%	12406	VX5A224K	1-57319
RESISTOR						
R8801	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R8802	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R8803	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R8804	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R8805	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R8806	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R8807	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R8808	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R8809	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R8810	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
R8811	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R8812	18KΩ	COMP	1/4W 5%	01121	CB-1835	7-41258
R8813	1.8KΩ	COMP	1/4W 5%	01121	CB-1825	7-41246
R8814	27KΩ	COMP	1/4W 5%	01121	CB-2735	7-41260
R8815	470Ω	COMP	1/4W 5%	01121	CB-4715	7-41239
R8816	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R8817	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R8818 - R8820	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R8821	5.6KΩ	COMP	1/4W 5%	01121	CB-5625	7-41252
R8822	33KΩ	COMP	1/4W 5%	01121	CB-3335	7-41261
R8823	15KΩ	COMP	1/4W 5%	01121	CB-1535	7-41257
R8824	8.2KΩ	COMP	1/4W 5%	01121	CB-8225	7-41254
R8825	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R8826	390KΩ	COMP	1/4W 5%	01121	CB-3945	7-41274
R8827	1MΩ	COMP	1/4W 5%	01121	CB-1055	7-41279
SEMICONDUCTOR						
CR8801 - CR8806		**CD-62 DIODE		15318		7-95507
CR8807		**CD-61 DIODE		15318		7-95511
CR8808		ZENER DIODE		JEDEC	1N710A	7-95627
CR8809		**CD-61 DIODE		15318		7-95511
CR8810		**CD-62 DIODE		15318		7-95507

PARTS LIST

ASSEMBLY: Range Detector

SCHEMATIC NO. 90-0788

CIMRON PART NO. 90-6088

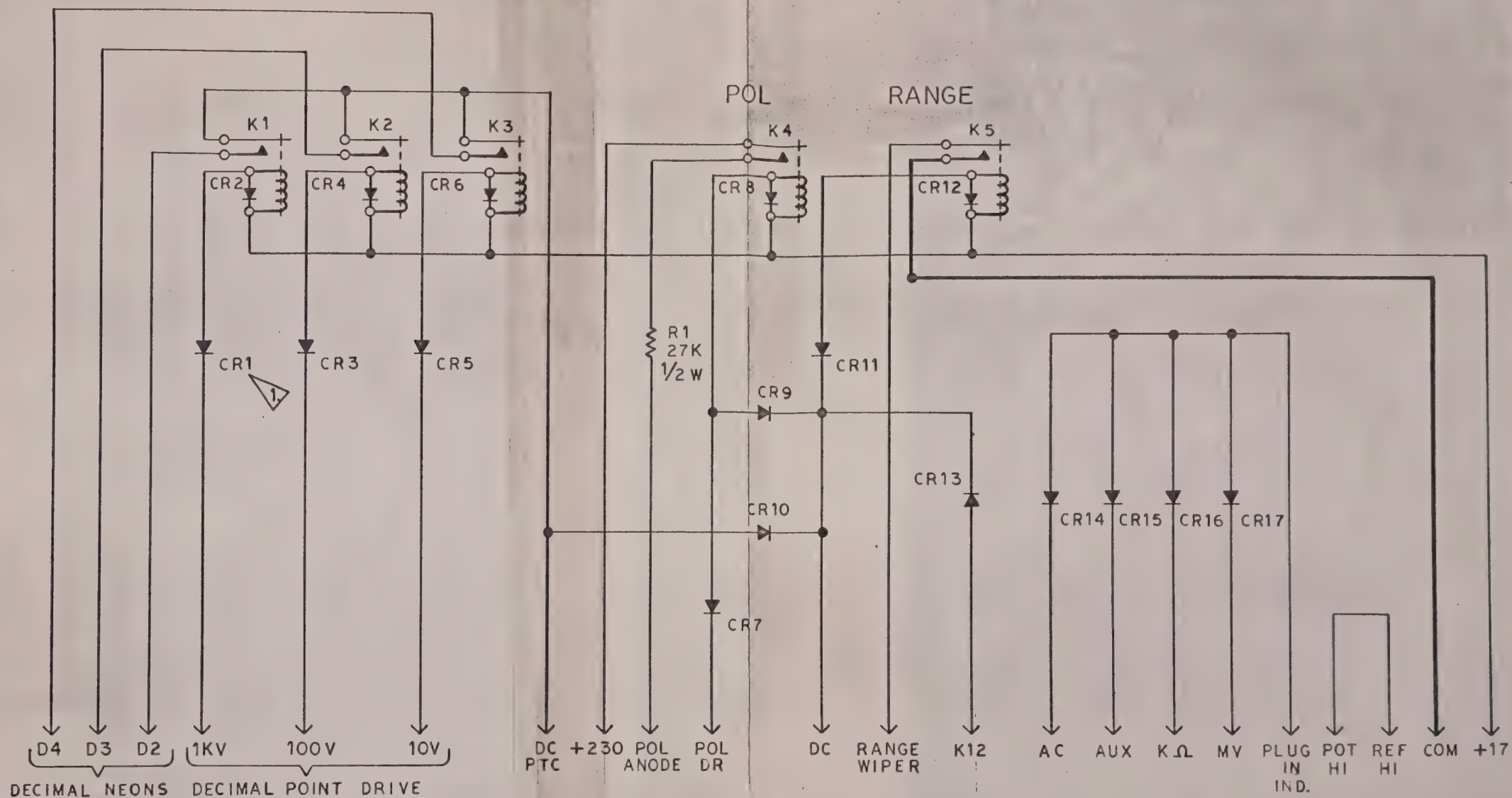
SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>SEMICONDUCTOR (Cont'd)</u>						
CR8811 - CR8813		**CD-61 DIODE		15318		7-95511
CR8814		ZENER DIODE		JEDEC	1N718A	7-95633
CR8815		**CD-61 DIODE		15318		7-95511
CR8816		**CD-62 DIODE		15318		7-95507
<u>TRANSISTOR</u>						
Q8801 - Q8805				JEDEC	2N404A	9-04609
Q8806		**CT-26		15318		9-04710
Q8807		**CT-23		15318		9-04706
Q8808		**CT-20		15318		9-04701
Q8809, Q8810		**CT-26		15318		9-04710
<u>REED</u>						
S8801, S8802		RELAY		95348	MR306-8	7-38216
<u>COIL</u>						
L8801, L8802		REED SWITCH ACTUATOR		15318		50-0501-1
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, RANGE				
		DETECTOR	15318			90-7088-1

NOTE**CD-61, $I_f = 1V$ greater than 100 ma, $I_r = 75V$ less than 1 ua, SILICON**CD-62, $I_f = 1V$ greater than 100 ma, $I_r = 300V$ less than 6 ua, SILICON

**CT-20 = 2N697

**CT-23 = 2N697

**CT-26 = 2N2222



- NOTES
- PARTIAL REFERENCE DESIGNATIONS SHOWN, FOR COMPLETE DESIGNATOR ADD 1600. EXAMPLE: CR1 IS 1601.
 - ALL DIODES ARE CD 62, RATING IS $\frac{100\text{MA}}{300\text{PIV}}$

Schematic 18A. Function.

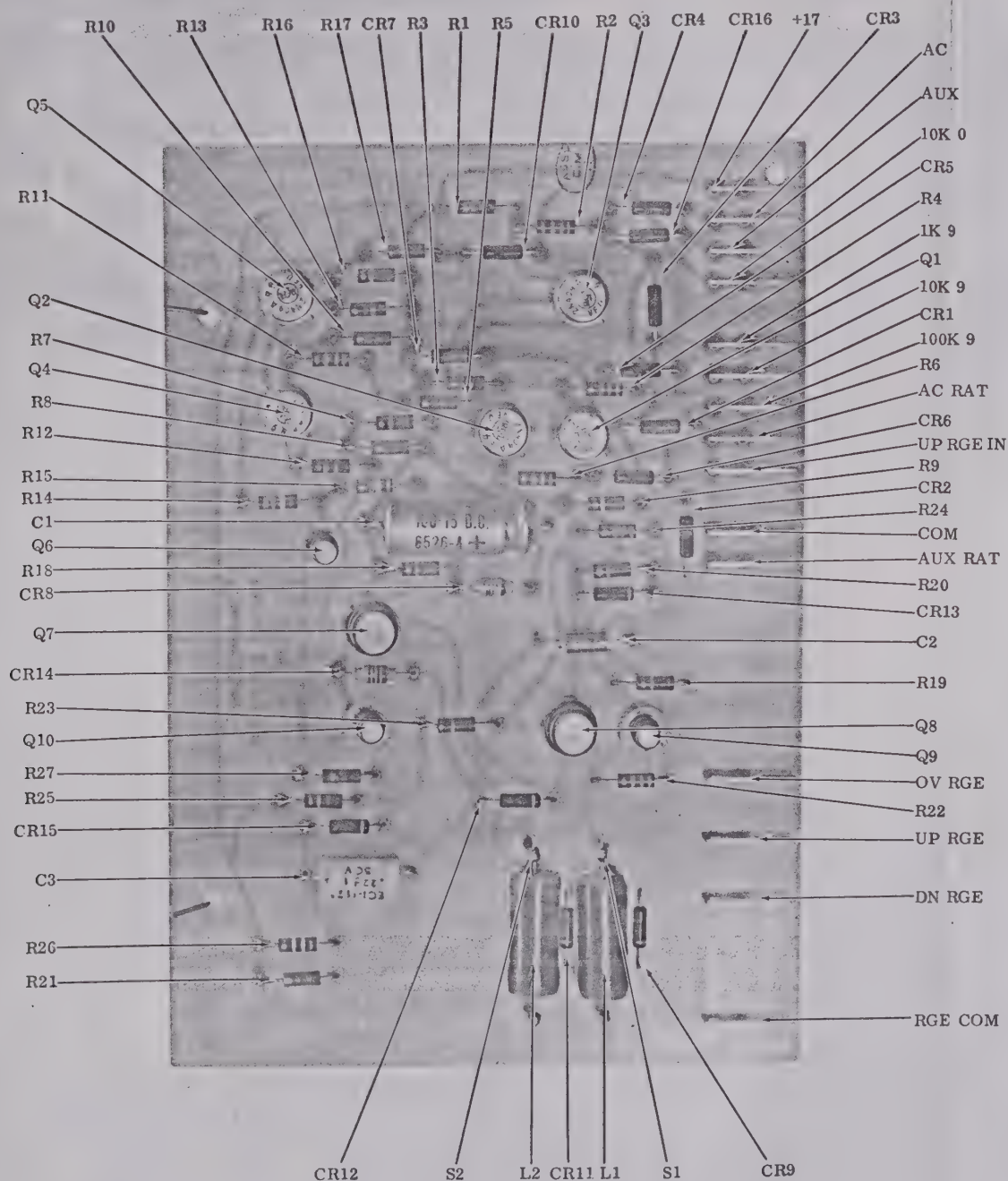


Figure 6-18. Range Detector.

POWER SUPPLY

ASSEMBLY 90-6017

SECTION VI

PARTS LIST

ASSEMBLY: Power Supply

SCHEMATIC NO. 90-0717

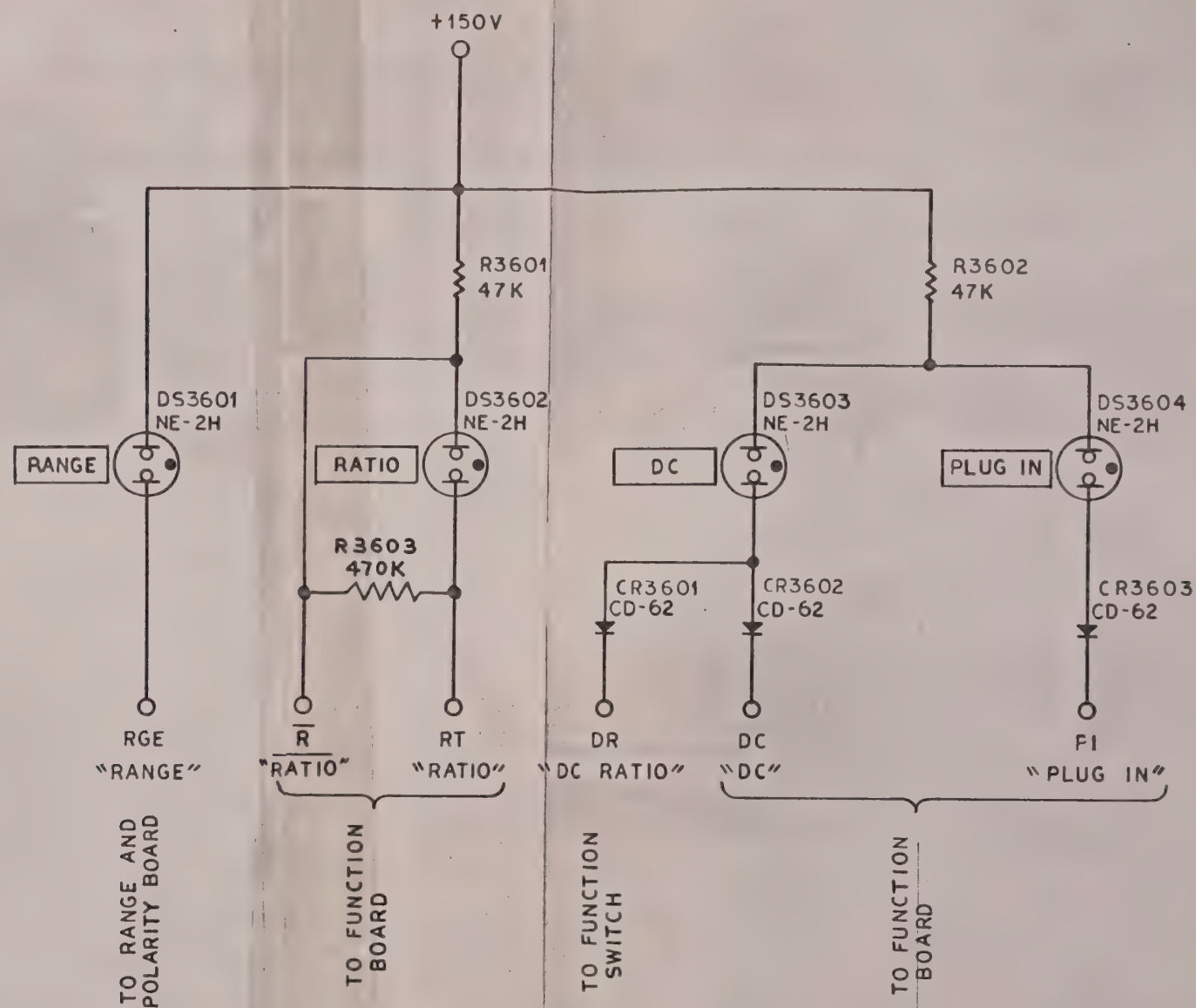
CIMRON PART NO. 90-6017

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C1701 - C1706	100uf	ELECT	25V	14655	NLW 100-25	1-57253
C1707	200uf	ELECT	15V	14655	NLW 200-15	1-57248
C1708	5nf	DISC	50V	71590	CK-502	1-57512
C1709	100uf	ELECT	25V	14655	NLW 100-25	1-57253
<u>RESISTOR</u>						
R1701	1KΩ	WW	3W 5%	56289	242E-1025	7-47140
R1702 - R1704	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R1705	22Ω	COMP	1/2W 5%	01121	EB-2205	7-41023
R1706	1KΩ	COMP	1/4W 5%	01121	CB-1025	7-41243
R1707, R1708	1Ω	WW	3W 1%	04387	RS-2B	7-47208
R1709	2.2KΩ	COMP	1/4W 5%	01121	CB-2225	7-41247
<u>SEMICONDUCTOR</u>						
VR1701, VR1702	ZENER DIODE			JEDEC	1N712A	7-95632
CR1701 - CR1703	**CD-61 DIODE			15318		7-95511
<u>TRANSISTOR</u>						
Q1701				JEDEC	2N2538	9-04711
Q1702	**CT-26			15318		9-04710
<u>MISCELLANEOUS</u>						
TP7	TEST JACK, VIOLET			82042	TJ-51-10	5-19010
TP8	TEST JACK, GRAY			82042	TJ-51-9	5-19009
TP9	TEST JACK, WHITE			82042	TJ-51-1	5-19001
TP10	TEST JACK, BLACK			82042	TJ-51-3	5-19003
TP11	TEST JACK, BROWN			82042	TJ-51-4	5-19004
	ETCHED BOARD, POWER SUPPLY			15318		90-7017-3
	HEAT SINK					4-65000

NOTE

**CD-61, $I_F = 1V$ greater than 100 ma, $I_R = 75V$ less than 1 ua, SILICON

**CT-26 = 2N2222



NOTES ◇

1. UNLESS OTHERWISE NOTED RESISTORS ARE 1/4W, ±5% TOLERANCE.

Schematic #19. Function Indicator.

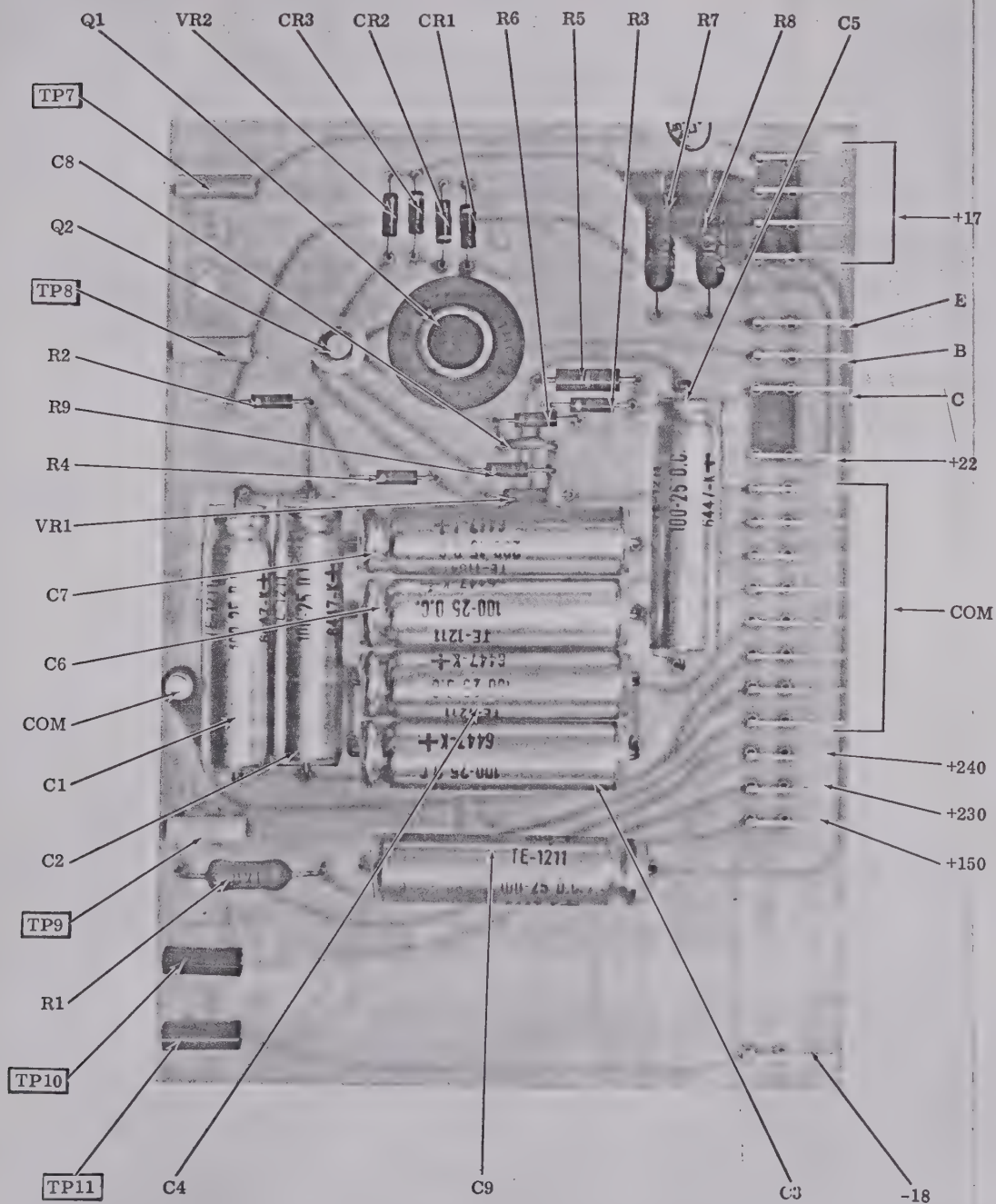


Figure 6-19. Power Supply.

PRINT CONTROL

ASSEMBLY 90-6102

PARTS LIST

CIMRON ASSEMBLY: Print Control SCHEMATIC NO. 90-0802 CIMRON PART NO. 90-6102

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITOR						
C201	22nf	DIP PAP	400V	04062	4DP-2-223	1-57415
C202, C203	1.8nf	CER DISC	10%	71590	DD-182	1-57503
C204	5nf	CER DISC	50V	71590	CK-502	1-57512
C205, C206	1μf	MET PAP	50V 10%	12406	VX5A105K	1-57317
C207	25μf	ELECT	25V	14655	NLW 25-25	1-57223
C208, C209	0.01μf	CER DISC	50V	71590	CK-103	1-57513
C210, C211	5nf	CER DISC	50V	71590	CK-502	1-57512
C212	1.8nf	CER DISC	10%	71590	DD-182	1-57503
C213	22μf	TANT	35V	01295	SCM226GP035D4	1-57102
C214	4.7μf	TANT	35V	01295	SCM475BP035D4	1-57106
C215 - C219	5nf	CER DISC	50V	71590	CK-502	1-57512

RESISTOR

R201	6.8K Ω	COMP	1/4W 5%	01121	CB-6825	7-41253
R202	27K Ω	COMP	1/4W 5%	01121	CB-2735	7-41260
R203	10K Ω	COMP	1/4W 5%	01121	CB-1035	7-41255
R204	4.7K Ω	COMP	1/4W 5%	01121	CB-4725	7-41251
R205	47K Ω	COMP	1/4W 5%	01121	CB-4735	7-41263
R206	6.8K Ω	COMP	1/4W 5%	01121	CB-6825	7-41253
R207	100K Ω	COMP	1/4W 5%	01121	CB-1045	7-41267
R208, R209	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R210	100K Ω	COMP	1/4W 5%	01121	CB-1045	7-41267
R211	1M Ω	COMP	1/4W 5%	01121	CB-1055	7-41279
R212	100K Ω	COMP	1/4W 5%	01121	CB-1045	7-41267
R213	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R214	500K Ω	VARIABLE		11237	220S504B	7-48810
R215	100K Ω	COMP	1/4W 5%	01121	CB-1045	7-41267
R216	1M Ω	COMP	1/4W 5%	01121	CB-1055	7-41279
R217	68K Ω	COMP	1/4W 5%	01121	CB-6835	7-41265
R218	33K Ω	COMP	1/4W 5%	01121	CB-3335	7-41261
R219	680 Ω	COMP	1/4W 5%	01121	CB-6815	7-41241
R220	6.8K Ω	COMP	1/4W 5%	01121	CB-6825	7-41253
R221	22K Ω	COMP	1/4W 5%	01121	CB-2235	7-41259
R222	10K Ω	COMP	1/4W 5%	01121	CB-1035	7-41255
R223	100K Ω	COMP	1/4W 5%	01121	CB-1045	7-41267
R224	15K Ω	COMP	1/4W 5%	01121	CB-1535	7-41257
R225	3.3K Ω	COMP	1/4W 5%	01121	CB-3325	7-41249
R226	470 Ω	COMP	1/4W 5%	01121	CB-4715	7-41239
R227	3.3K Ω	COMP	1/4W 5%	01121	CB-3325	7-41249
R228	4.7K Ω	COMP	1/4W 5%	01121	CB-4725	7-41251
R229	56K Ω	COMP	1/4W 5%	01121	CB-5635	7-41264
R230	1M Ω	COMP	1/4W 5%	01121	CB-1055	7-41279
R231	100K Ω	COMP	1/4W 5%	01121	CB-1045	7-41267

PARTS LIST

CIMRON ASSEMBLY: Print Control SCHEMATIC NO. 90-0802 CIMRON PART NO. 90-6102

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTOR (Cont'd)						
R232	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231
R233	4.7KΩ	COMP	1/4W 5%	01121	CB-4725	7-41251
R234	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R235	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R236	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R237	100KΩ	VARIABLE		11237	220S104B	7-48809
R238	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R239, R240	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R241	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R242	6.8KΩ	COMP	1/4W 5%	01121	CB-6825	7-41253
R243	10KΩ	COMP	1/4W 5%	01121	CB-1035	7-41255
R244	100KΩ	COMP	1/4W 5%	01121	CB-1045	7-41267
R245	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
R246 - R249	100Ω	COMP	1/4W 5%	01121	CB-1015	7-41231

SEMICONDUCTOR

CR201 - CR224	*CD-61 DIODE	15318		7-95511
VR201	ZENER DIODE	JEDEC	1N714A	7-95630

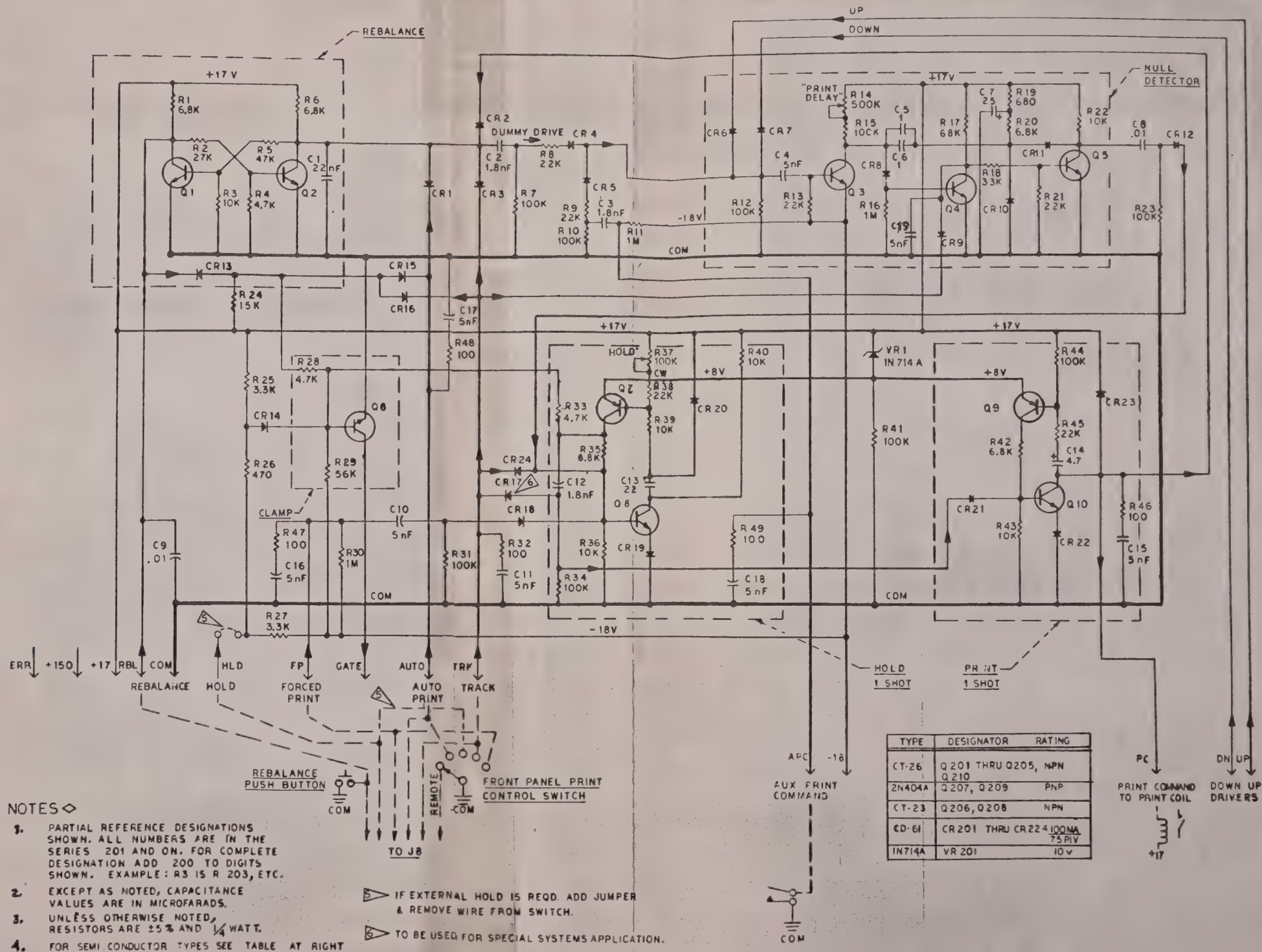
TRANSISTOR

Q201 - Q205	CT-26 or 2N2222	15318		9-04710
Q206	CT-23 or 2N697	15318		9-04706
Q207		JEDEC	2N404A	9-04609
Q208	CT-23 or 2N697	15318		9-04706
Q209		JEDEC	2N404A	9-04609
Q210	CT-26 or 2N2222	15318		9-04710

MISCELLANEOUS

ETCHED CIRCUIT BOARD	15318	90-7102-3b
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*CD-61, $I_F = 1V$ greater than 100 ma, $I_R = 75V$ less than 1 ua, SILICON



Schematic #22. Print Control.

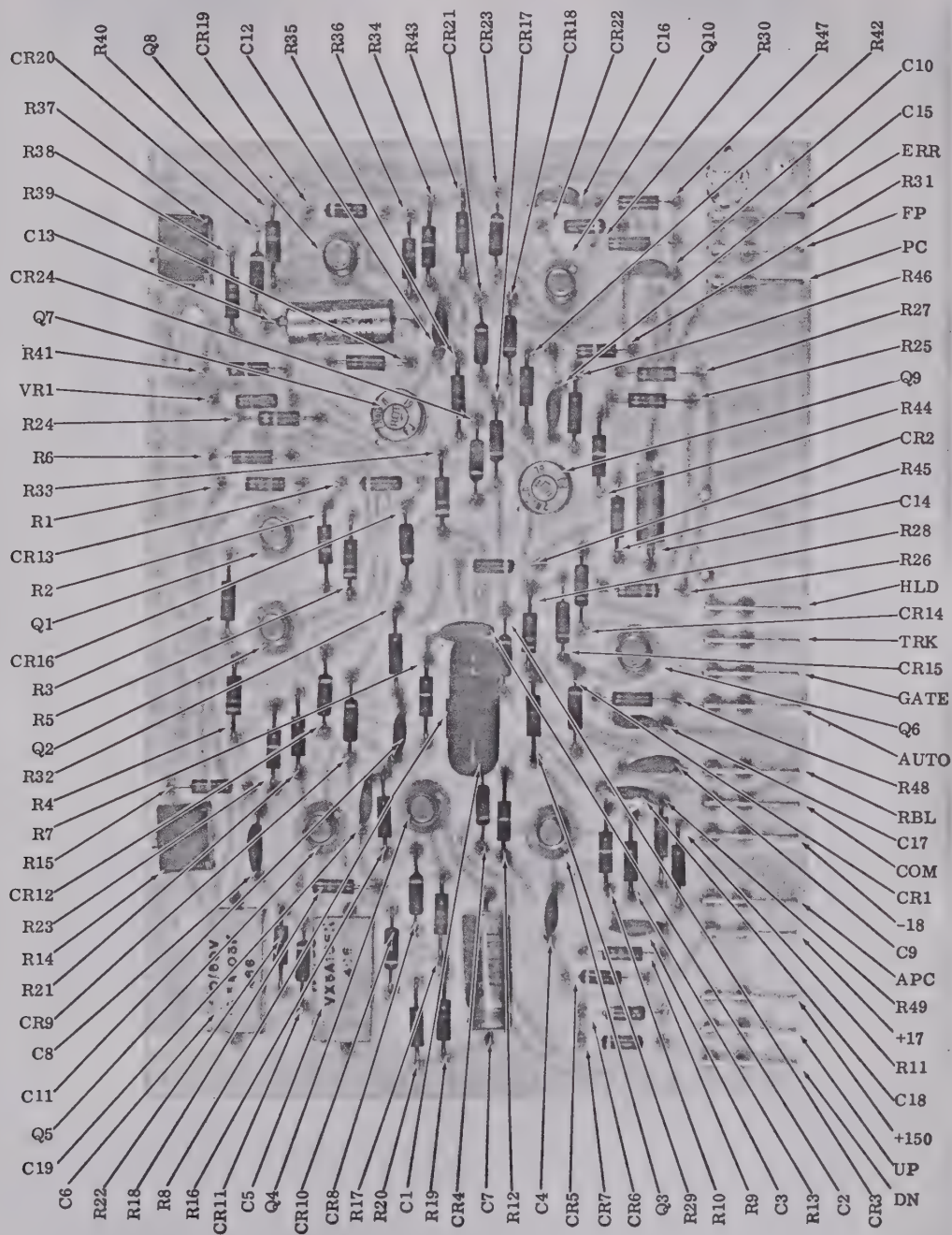


Figure 6-20. Print Control.

PRINT OUTPUT A

ASSEMBLY 90-6040

PRINT OUTPUT B

ASSEMBLY 90-6041

PRINT OUTPUT C

ASSEMBLY 90-6042

PARTS LIST

ASSEMBLY: Print Output "A"

SCHEMATIC NO. 90-5020

CIMRON PART NO. 90-6040

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>SEMICONDUCTOR</u>						
CR4001 - CR4023		**CD-61 DIODE		15318		7-95511
CR4024 - CR4046		**CD-62 DIODE		15318		7-95507
<u>REED</u>						
S4001 - S4023		RELAY		95348	MR-306-8	7-38216
<u>COIL</u>						
L4001 - L4023		REED SWITCH ACTUATOR		15318		90-0504-1
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, PRINT OUTPUT "A"		15318		90-7040-1

ASSEMBLY: Print Output "B"

SCHEMATIC NO. 90-5020

CIMRON PART NO. 90-6041

<u>SEMICONDUCTOR</u>						
CR4101 - CR4123		**CD-61 DIODE		15318		7-95511
CR4124 - CR4146		**CD-62 DIODE		15318		7-95507
<u>REED</u>						
S4101 - S4123		RELAY		95348	MR-306-8	7-38216
<u>COIL</u>						
L4101 - L4123		REED SWITCH ACTUATOR		15318		90-0504-1
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, PRINT OUTPUT "B"		15318		90-7041-1

ASSEMBLY: Print Output "C"

SCHEMATIC NO. 90-5020

CIMRON PART NO. 90-6042

<u>SEMICONDUCTOR</u>						
CR4201 - CR4224		**CD-61 DIODE		15318		7-95511
CR4225 - CR4248		**CD-62 DIODE		15318		7-95507
<u>REED</u>						
S4201 - S4224		RELAY		95348	MR-306-8	7-38216
<u>COIL</u>						
L4201 - L4224		REED SWITCH ACTUATOR		15318		90-0504-1
<u>MISCELLANEOUS</u>						
		ETCHED BOARD, PRINT OUTPUT "C"		15318		90-7042-1

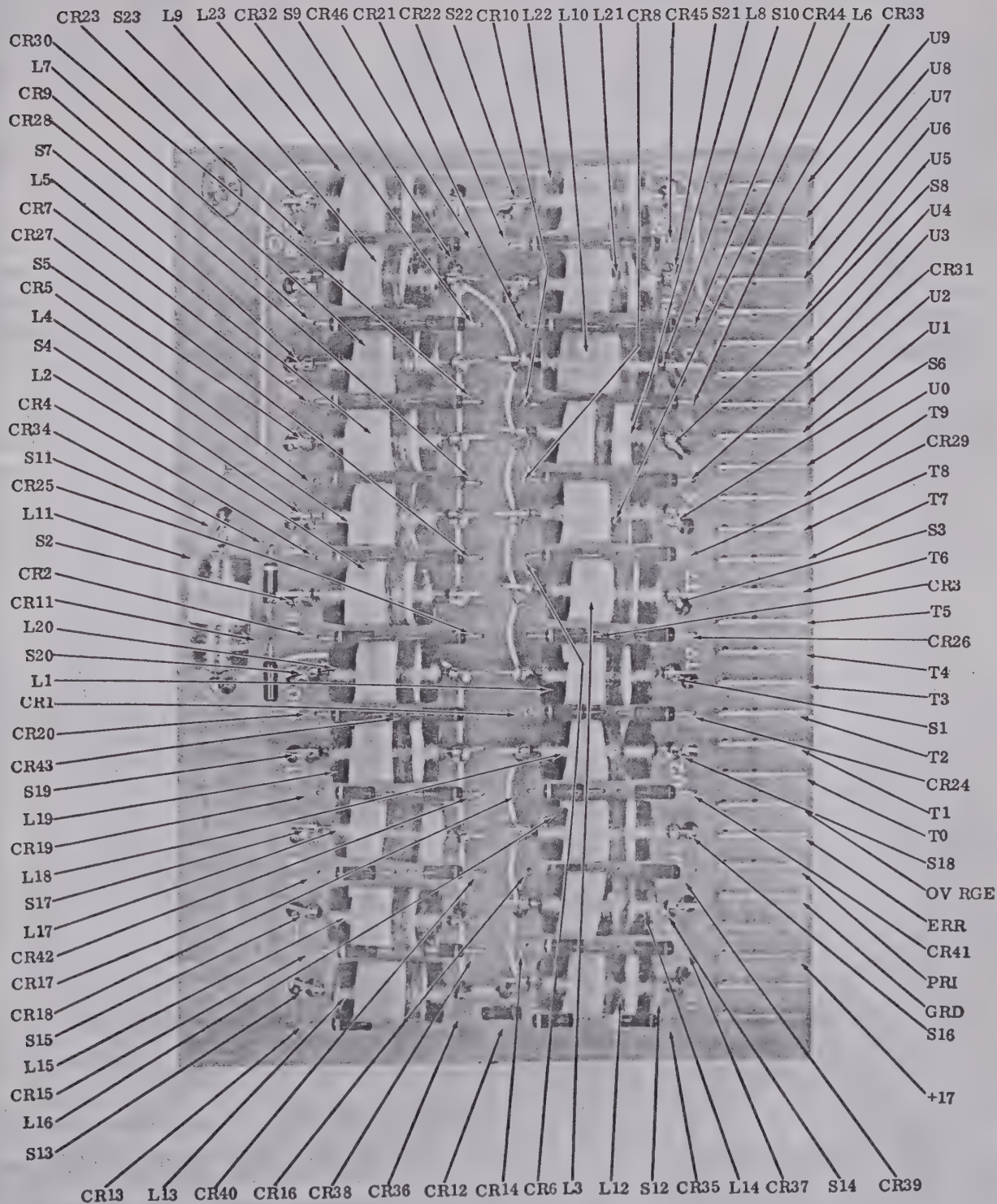


Figure 6-21 Print Output A.

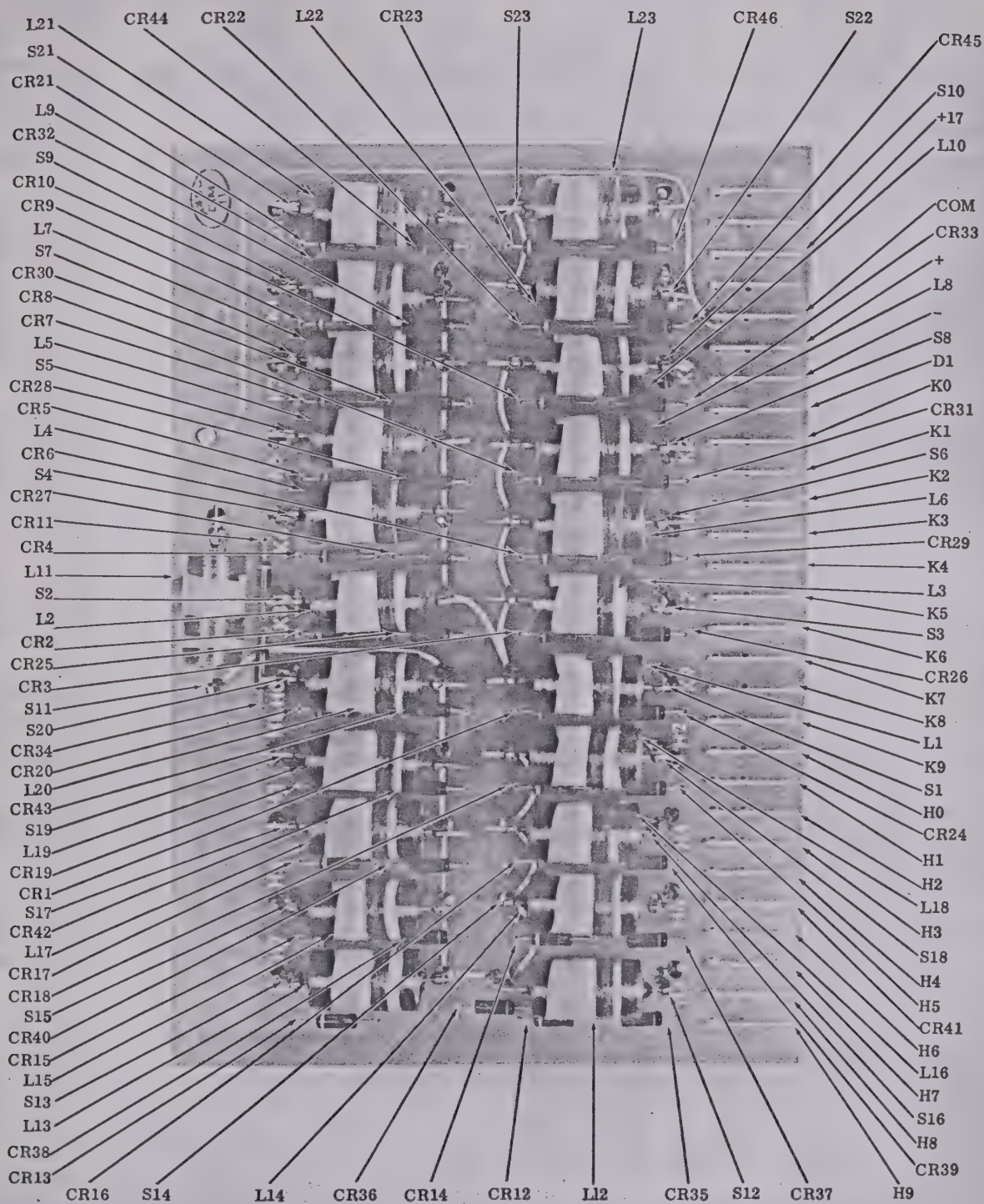


Figure 6-22. Print Output B.

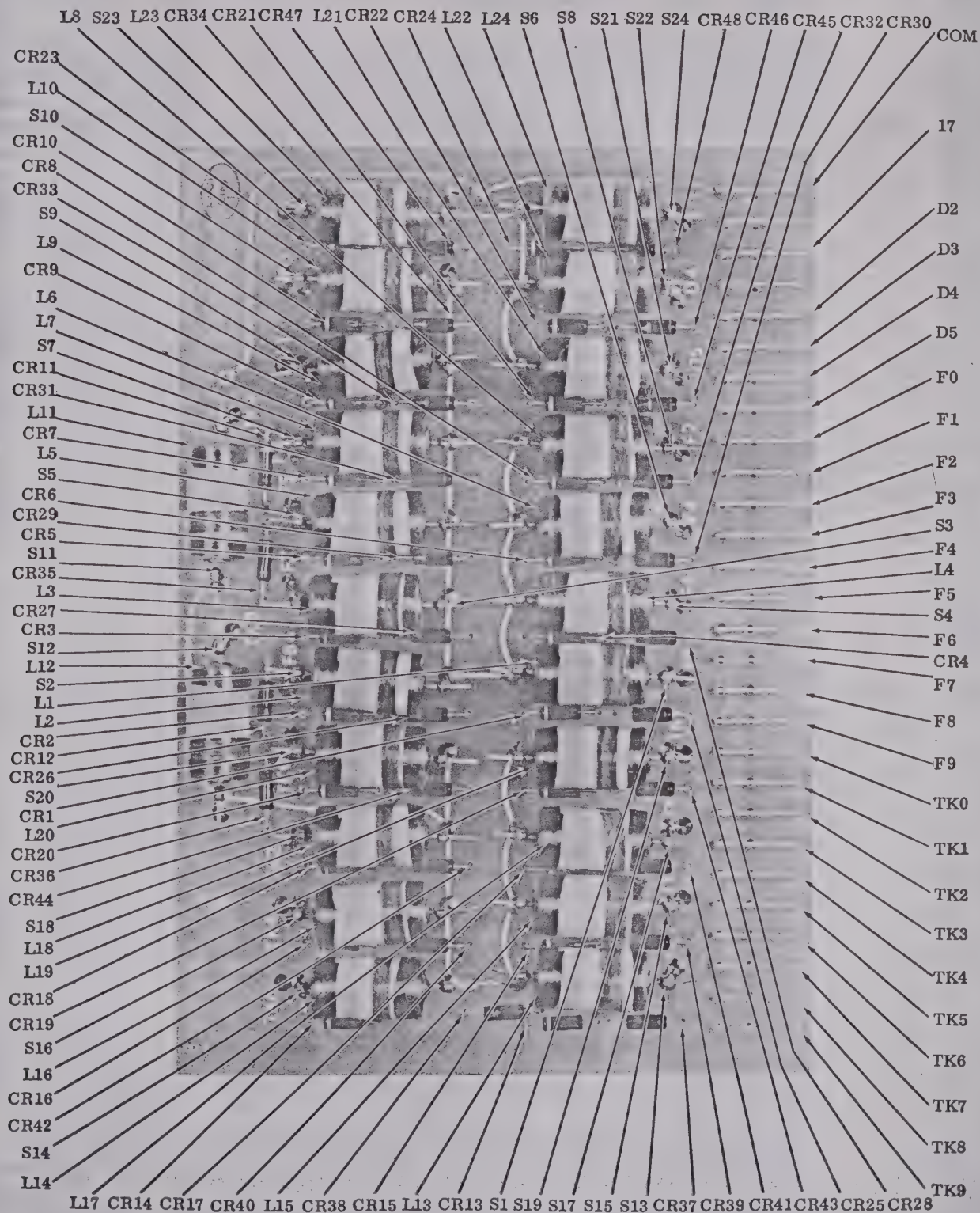
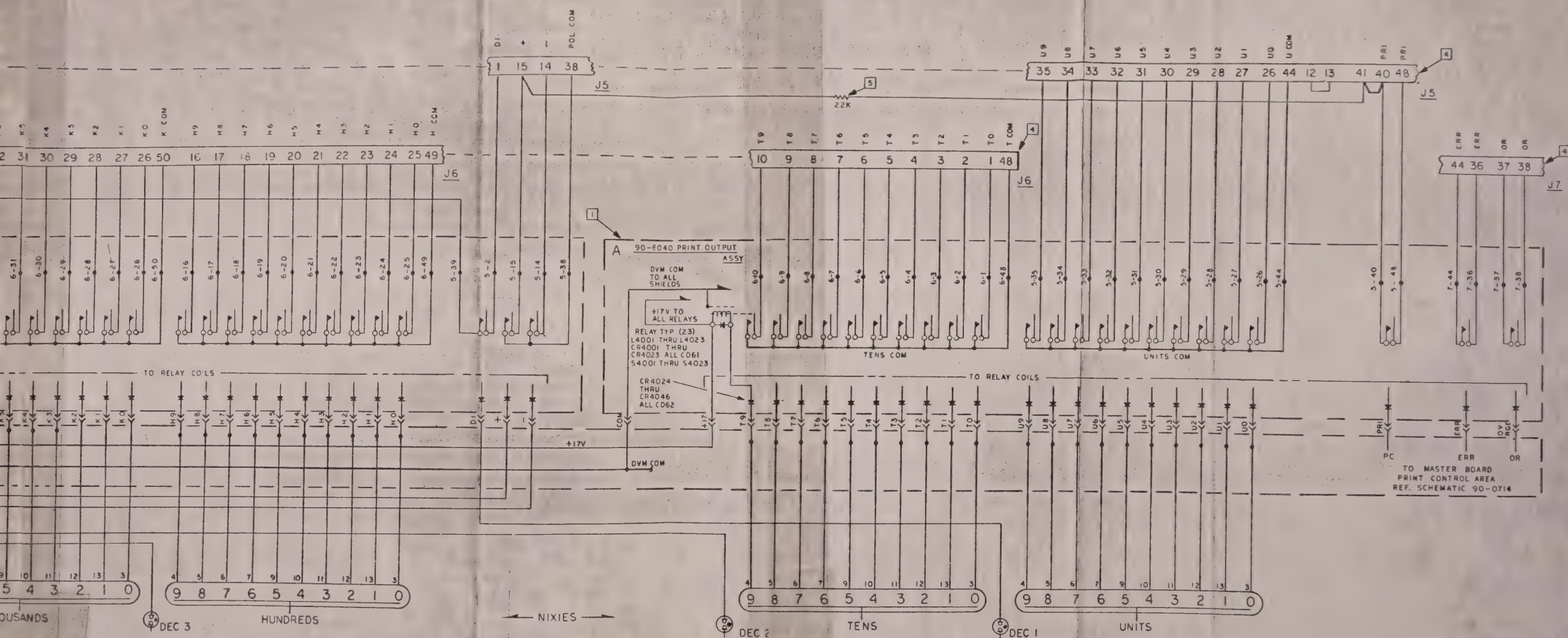


Figure 6-23. Print Output C.



Schematic #23. Print Output.

SUB-ASSEMBLIES

PARTS LIST
MASTER ASSEMBLY

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>CAPACITOR</u>						
C1, C2	1000/1000uf	ELECT	50V	00853	505-3840-02	1-58015
C3	150/150/150uf	ELECT	250V	00853	505-2624-02	1-58016
C4	10uf	MET PAP	100V 10%	12406	VX1A106K	1-57341
<u>RESISTOR</u>						
R1	20Ω	WW	3W 1%	04387	RS-2B	7-47154
R2 - R4	2.2MΩ	COMP	1/4W 5%	01121	CB-2255	7-41283
R5 - R9	27KΩ	COMP	1/2W 5%	01121	EB-2735	7-41060
R10 - R16	470KΩ	COMP	1/4W 5%	01121	CB-4745	7-41275
R17	150KΩ	COMP	1/2W 5%	01121	EB-1545	7-41069
R18	10KΩ	COMP, VAR, TRIM	2W	15318		60-0506-3
R19	680Ω	COMP	1/4W 5%	01121	CB-6815	7-41241
R20	3.9KΩ	COMP	1/4W 5%	01121	CB-3925	7-41250
R21	22KΩ	COMP	1/4W 5%	01121	CB-2235	7-41259
<u>SEMICONDUCTOR</u>						
CR1 - CR8		DIODE		14099	SC-2	7-95502
CR9 - CR16		DIODE		14099	SC-6	7-95504
CR17		DIODE		15318	*CD-62	7-95507
<u>TRANSISTOR</u>						
Q1				01295	TI 1135	9-04713
<u>CONNECTOR</u>						
J1F, J1R		REC, 8 PIN		71468	KPT7A12-8PAY	2-52007
J2		REC, 5 PIN		71468	XLR-5-14	2-52001
J3, J5, J6, J7		REC, MINI, 50 PIN		02660	57-40500	2-50150
J8		REC, 14 PIN		02660	57-40140	2-50140
J10A, J10B		REC, 24 PIN		02660	26-4200-24S	2-50024
P3		PLUG, 50 PIN		02660	57-30500	2-40150
P8		PLUG, 14 PIN		02660	57-30140	2-40140
<u>SWITCH</u>						
S1		POWER		15318		8-64050
S3		SPR LOADED, 2 POL, 5 POS		15318		8-64029
S4		PUSHBUTTON, SPST, (NO)		81073	39-1	8-64105
S5		1 POL, 12 POS, WITH ADJ STOP		15318		8-64021
S7		SLIDE, DPDT		42190	4633	8-64005
S8		SLIDE, DPDT, MARKED 230/115		42190	4633	8-65004

PARTS LIST
MASTER ASSEMBLY

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>PANEL ASSEMBLY</u>						
		FRONT		15318		90-2036-1
		SIDES (TWO)		15318		11-2019-1
		REAR		15318		90-2037-1
<u>SHIELD ASSEMBLY</u>						
		RIGHT		15318		90-2039-1
		LEFT		15318		90-2038-1
		SWITCH		15318		90-3041-1
		BOTTOM		15318		90-3028-1
		TOP		15318		90-3093-3
<u>TRACK</u>						
		PLUG IN		15318		90-2040-1
		REAR		15318		90-3056-1
		FRONT		15318		90-3054-1
		CENTER		15318		90-3055-1
<u>COVER</u>						
		COVER CASE		15318		11-3064-1
		SIDE PANEL		15318		11-3071-1
		MOUNTING BRACKET		15318		11-3047-1
<u>BRACKET</u>						
		SIDE PANEL		15318		90-3058-1
		TRANSFORMER		15318		90-2050-1
		RACK MOUNTING		15318		90-3022-3
<u>MISCELLANEOUS</u>						
		CORD, AC POWER		15318		2-70003
		FUSE HOLDER		75915	342004	4-12000
		GROMMET - POWER CORD				
		STRAIN RELIEF		28520	SR-6P-1	4-35000
		POST, BINDING		83330	136	6-94005
		BEZELS		15318		11-3072-1
		RETAINER, POLARIZER		15318		60-3013-3
		STRAP HOLDER, TOOL		15318		70-3005-1
		TOOL, EXTRACTION		15318		70-9500-1
		BLOCK, INSULATING, MASTER				
		BOARD SUPPORT		15318		80-3012-1
		INSTRUMENT BAIL		15318		8-16502

PARTS LIST

MASTER ASSEMBLY

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		CIMRON PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
<u>MISCELLANEOUS (Cont'd)</u>						
		KNOB, SKIRT, 1/4" SHAFT		15318		90-0514-1
		CHASSIS ASSEMBLY, PLUG IN		15318		90-2018-1
		CHASSIS, NIXIE AND SWITCH		15318		90-3001-1
		ROD, EXTENSION		15318		90-3016-1
		POLARIZER, READOUT		15318		90-3017-1
		BAR, INSULATING		15318		90-3018-1
		ANGLE, BEZEL MOUNTING		15318		90-3059-1
		BLOCK, SUPPORT		15318		90-3034-1
		INPUT CABLE ASSEMBLY		15318		90-5004-3
		ETCHED BOARD, RECTIFIER		15318		90-7039-1
		ETCHED BOARD, MASTER		15318		90-7070-9
D1 - D5		LAMP, INDICATOR		03797	1B9A-6488	5-63000
DS1 - DS5		SUPER NIXIE		92379	B6033	3-41405
DS6		POL NIXIE		92379	B6034	3-41404
F1		FUSE, 3 AG, S-B, 1/2A		75915	313,500	4-08013
T1		TRANSFORMER, POWER		15318		90-0506-1
XDS1 - XDS6		SOCKET, 13 PIN		92379	SK 112	8-24000

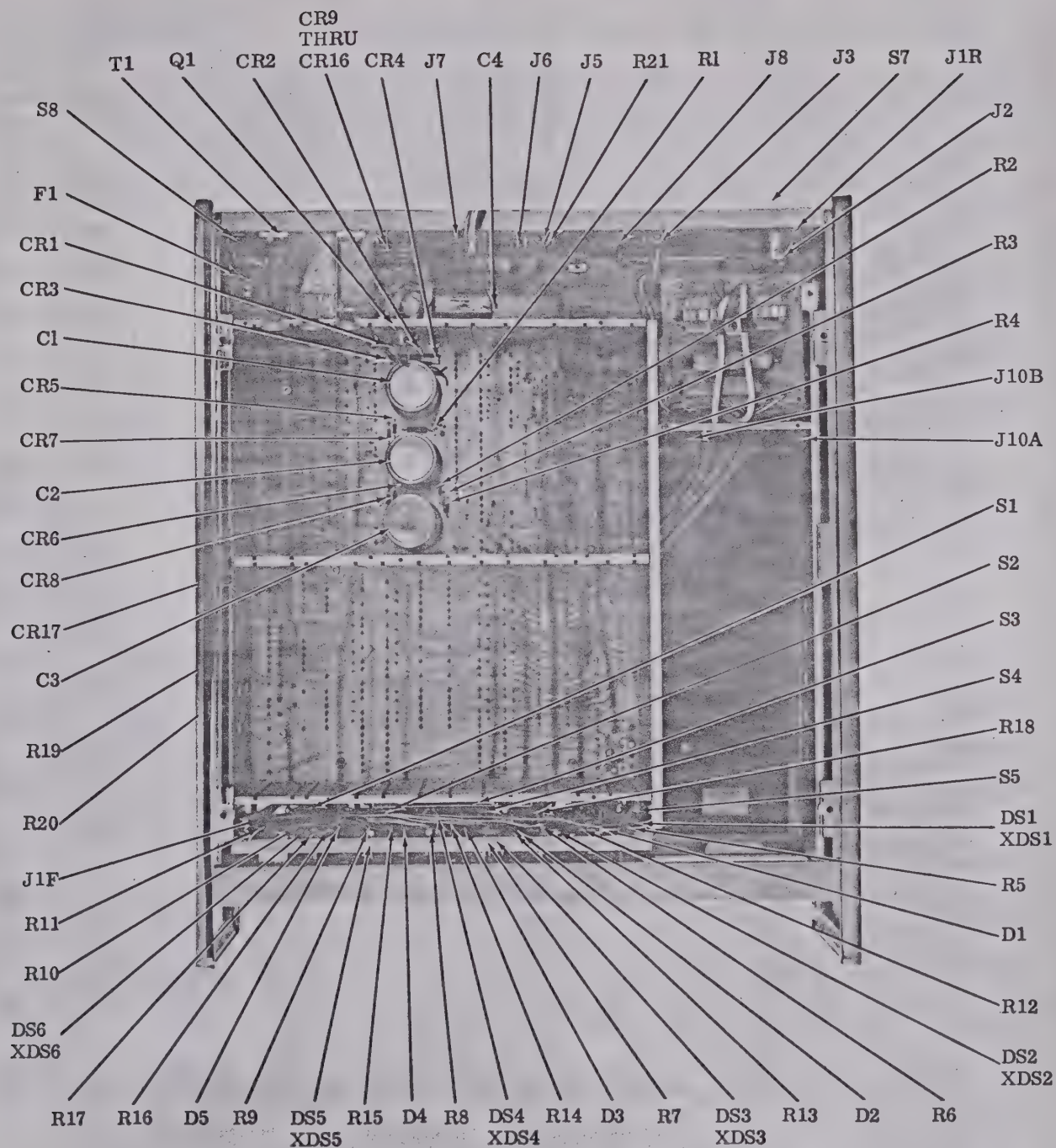
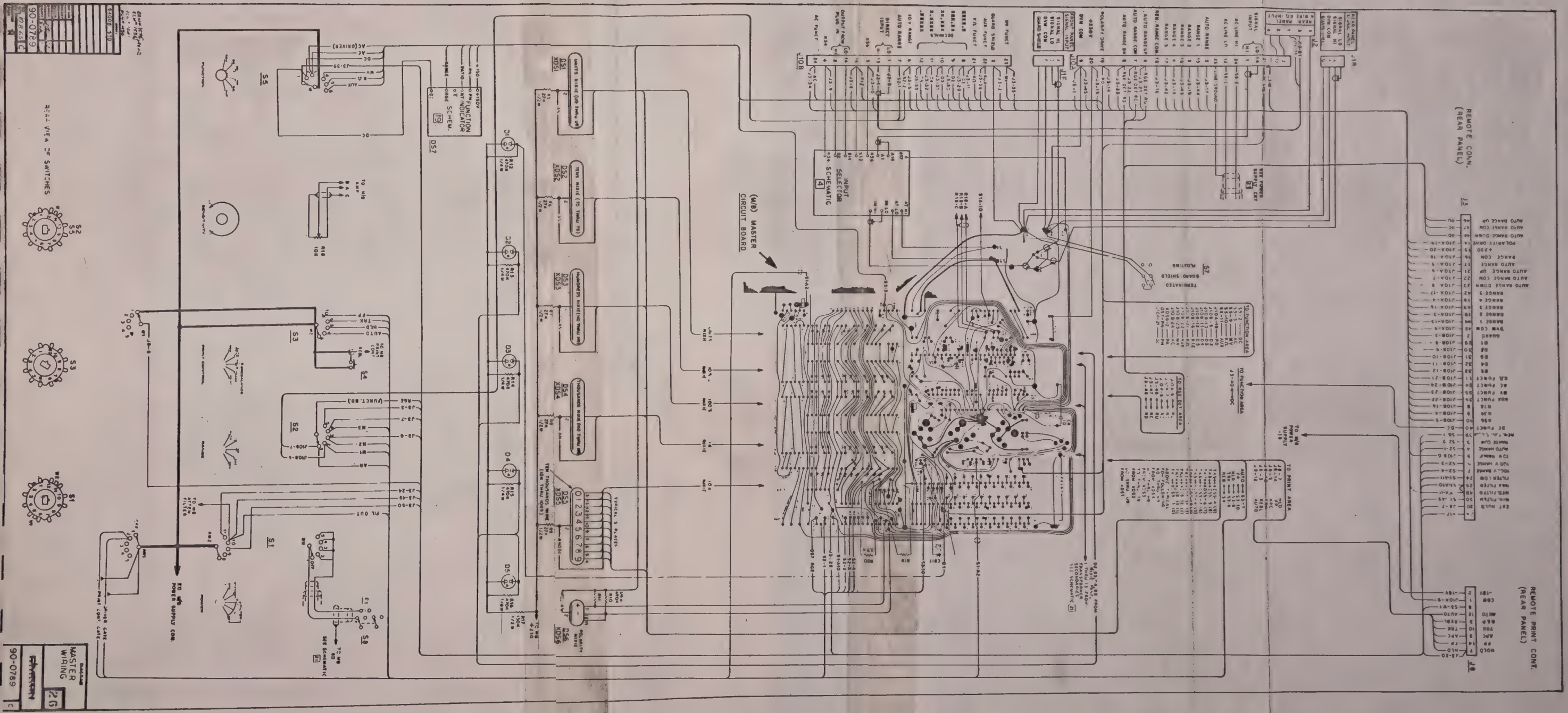


Figure 6-24. Master Assembly.





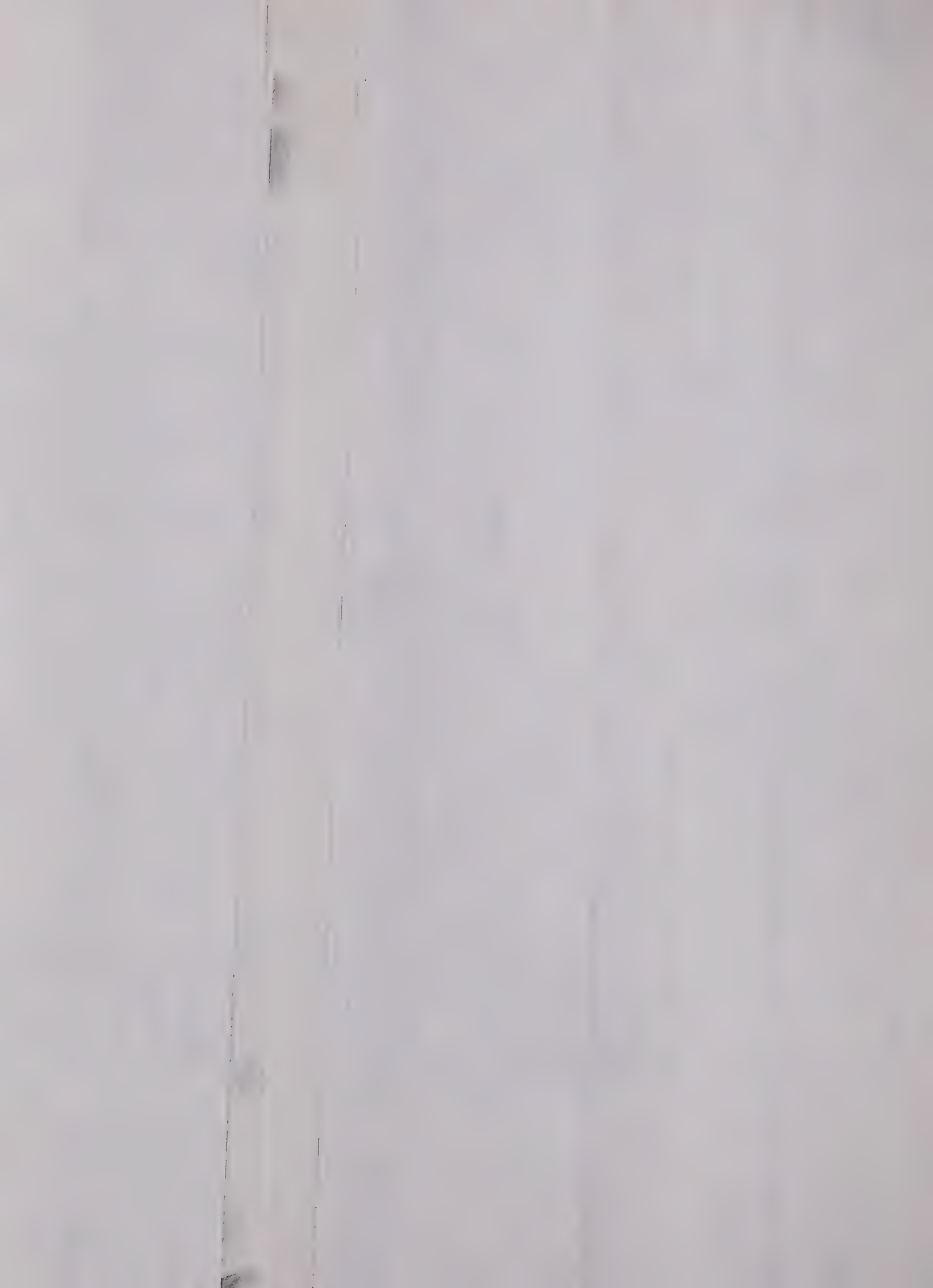
Schematic 25. Master Wiring, P9400B.

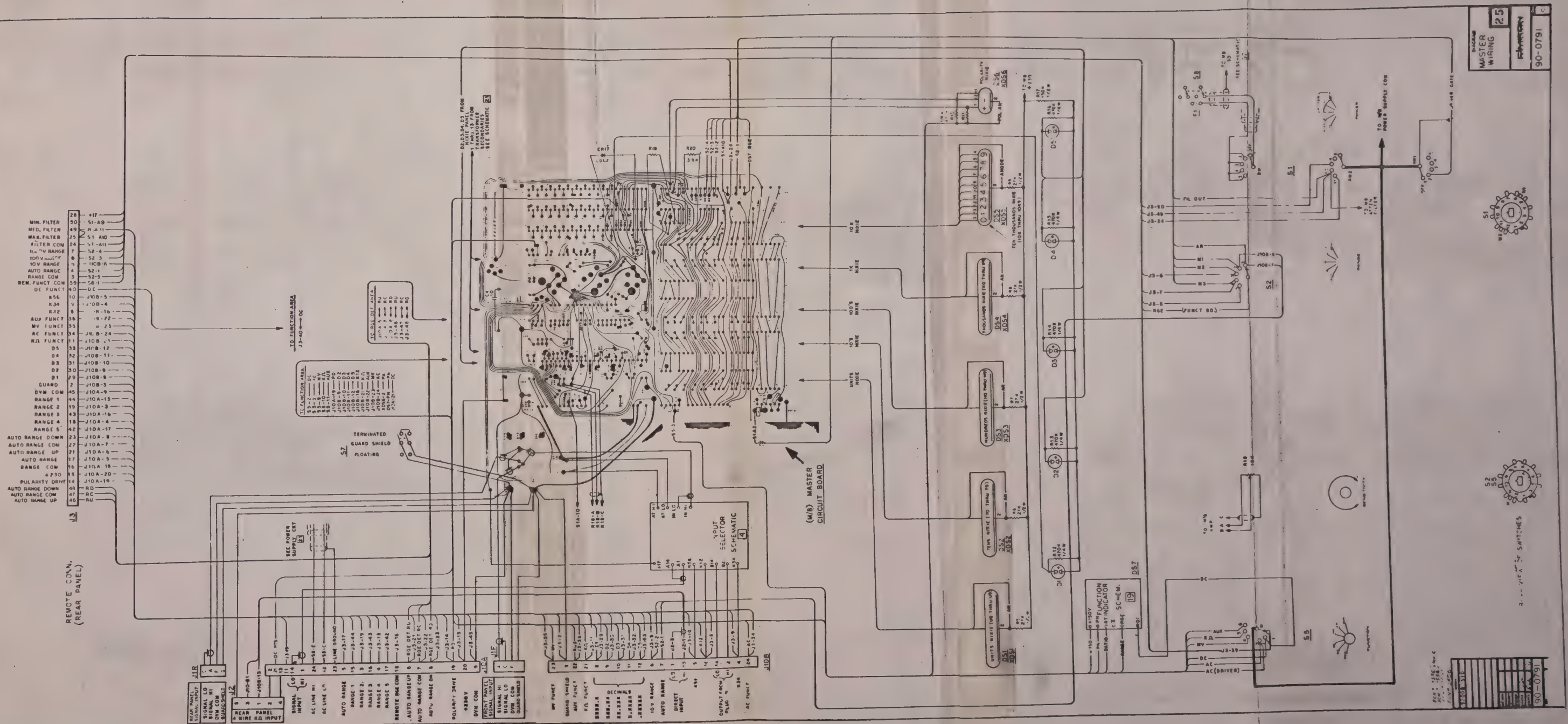












Schematic 27. Master Wiring, P9200B.

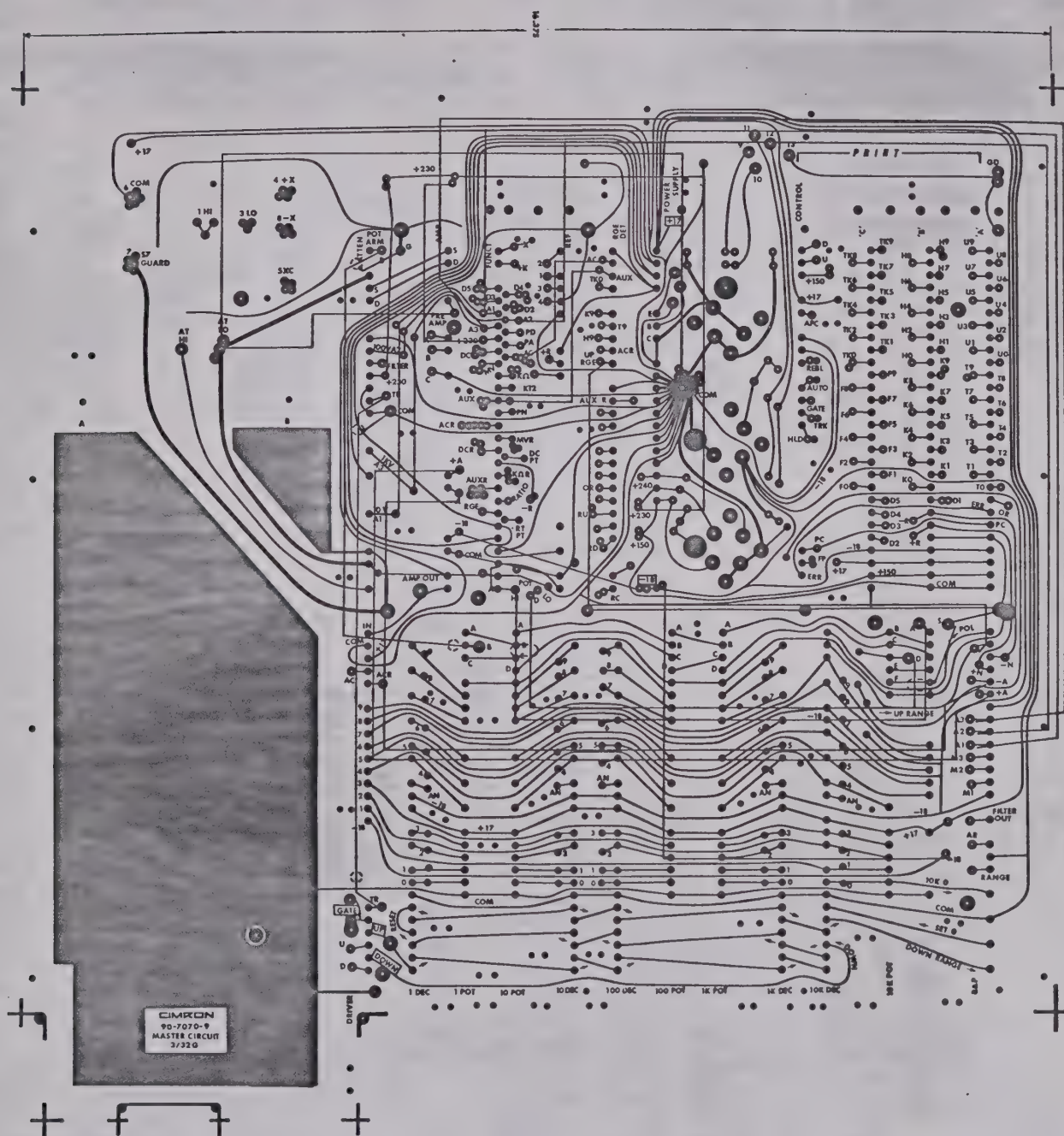


Figure 6-28. Jumpers Installed on Master Board of P9200B.

SECTION VII

RECOMMENDED SPARE PARTS

The following is a list of the recommended spare parts required to maintain a specific number of instruments at a satisfactory level of performance for one year in an isolated area.

TABLE XII
Recommended Spare Parts.

ASSEMBLY OR PART NAME	ASSEMBLY OR PART NUMBER	QUANTITY OF PARTS		
		1 Instrument	5 Instruments	10 Instruments
Attenuator Assembly	90-6001	1	3	5
Amplifier Assembly	90-6077	1	3	5
Driver Assembly	90-6075	1	3	5
Standard Decade Assembly	90-6047	1	3	5
Unit Potentiometer Assembly	90-6104	1	3	5
10 Potentiometer Assembly	90-6105	1	3	5
100 Potentiometer Assembly	90-6106	1	3	5
1000 Potentiometer Assembly	90-6107	1	3	5
10K Potentiometer Assembly	90-6112	1	3	5
Range and Polarity Assembly	90-6113	1	3	5
Function Ratio Assembly*	90-6074	1	3	5
Function Assembly**	90-6116	1	3	5
Print Control Assembly	90-6102	1	3	5
10K Decade Assembly	90-6048	1	3	5
Power Supply Assembly	90-6017	1	3	5
Range Detector Assembly	90-6088	1	3	5
Reference Assembly	90-6114	1	3	5
Indicator Readout, Polarity	3-41404	1	1	2
Indicator Readout, Numeral	3-41405	1	3	5
Fuse	4-08013	5	10	10
Coil, Reed Switch Actuator	80-0502-1	1	3	5
Reed, Relay	7-38207	5	10	10
Indicator, Neon	5-46501	1	3	5

*P9300B and P9500B only

**P9200B and P9400B only

APPENDIX

TABLE OF CONTENTS

Section	Page
ABBREVIATIONS	A-2
MANUFACTURERS	A-3
WARRANTY	

APPENDIX

WORD	ABBREVIATION	WORD	ABBREVIATION
alternating current	AC	micro 10 ⁻⁶	u
ampere	A	milli 10 ⁻³	m
atto 10 ⁻¹⁸	a	miniature	MINI
bel	B	minimum	MIN
capacitor	CAP	minute	min
carbon	CAR	mylar	MY
centi 10 ⁻²	c	nano 10 ⁻⁹	n
ceramic disc	DISC	neon	Ne
common	COM	normally closed	NC
composition	COMP	normally open	NO
connector	CONN	note	*
cycles per second (hertz)	c/s	ohm	Ω
deci 10 ⁻¹	d	paper	PAP
degree Celsius	°C	peak	P
degree Fahrenheit	°F	peak to peak	PP
degree Kelvin	°K	pico 10 ⁻¹²	p
deka 10 ¹	da	polarity	POL
demodulator	DEMOD	polycarbonate	POLYCARB
deposited	DEP	polystyrene	POLY
digital voltmeter	DVM	position	POS
direct current	DC	potentiometer	POT
double pole double throw	DPDT	pound	lb
electrolytic	ELECT	receptacle	REC
encapsulated	ENCAP	resistor	RES
farad	F	root-mean-square	rms
fast-up	f-up	rotary	ROT
femto 10 ⁻¹⁵	f	second	s
fixed	FXD	siemens	S
germanium	Ge	silicon	Si
giga 10 ⁹	G	silicon controlled switch	SCS
gram	g	silver	sil
ground	gnd	single pole double throw	SPDT
guard	grd	single pole single throw	SPST
hecto 10 ²	h	spring	SPR
henry	H	tantalum	TANT
hertz	Hz	tera 10 ¹²	T
hour	h	thermistor	THERM
impedance	Z	trimmer	TRIM
indicator	IND	value selected at factory	*
Joint Electronic Device Engineering Council	JEDEC	variable	VAR
kilo 10 ³	k	volt	V
maximum	MAX	voltampere	VA
mega 10 ⁶	M	watt	W
metallized	MET	with	w/
meter	m	without	w/o
mho (siemens)	mho	wire wound	WW

LIST OF MANUFACTURERS
CODE TO NAME

FEDERAL SUPPLY CODE	MANUFACTURER	ADDRESS
00194	Walsco Electronics Corp.	Los Angeles, California
00348	Microtran Co., Inc.	Valley Stream, New York
00656	Aerovox Corp.	New Bedford, Massachusetts
00853	Sangamo Electric Co.	Pickens, South Carolina
01121	Allen Bradley Co.	Milwaukee, Wisconsin
01281	T. R. W. Semiconductors, Inc.	Lawndale, California
01295	Texas Instruments, Inc.	Dallas, Texas
02111	Spectrol Electronics Corp.	San Gabriel, California
02567	International Electronics Industries, Inc.	Nashville, Tennessee
02572	Inland Electronics Corp.	Aurora, Illinois
02660	Amphenol-Borg Electronics Corp.	Chicago, Illinois
02768	Fastex Division of Illinois Tool Works	Des Plaines, Illinois
03614	Bussmann Mfg.	Los Angeles, California
03797	Eldema Corp.	Compton, California
03877	Transitron Electronic Corp.	Wakefield, Massachusetts
03911	Clairex Corp.	New York, New York
04062	Elmenco Products Co.	New York, New York
04217	Essex Wire Corp.	Los Angeles, California
04264	Circon Components Co.	Goleta, California
04387	Dale Electronics, Inc., Pacific Division	Burbank, California
04852	Mosley Electronics, Inc.	Bridgeton, Missouri
05276	Pomona Electronics Co., Inc.	Pomona, California
05347	Ultronix, Inc.	San Mateo, California
05593	Illumitronic Engineering Co.	Sunnyvale, California
05704	Alac, Inc.	Glendale, California

FEDERAL
SUPPLY
CODE

MANUFACTURER

ADDRESS

05791	Lyn-Tron, Inc.	North Hollywood, California
06090	Raychem Corp.	Redwood City, California
06743	Clevite Corp.	Cleveland, Ohio
06751	U. S. Semcor Division of Nuclear Corp of America	Phoenix, Arizona
07088	Kelvin Electric Co.	Van Nuys, California
07115	Corning Glass, Electronic Components	Bradford, Pennsylvania
07150	Electro-Mech Components, Inc.	Van Nuys, California
07344	Bircher Co., Inc.	Rochester, New York
07382	Rotor Clip Co.	Bronx, New York
07694	Triad Corp.	Encino, California
07716	International Resistance Co.	Burlington, Iowa
07910	Continental Device Corp.	Hawthorne, California
08065	Accurate Rubber and Plastics Co.	San Diego, California
08538	Chicago Dynamic Industries, Inc.	Chicago, Illinois
08664	Bristol Co.	Waterbury, Connecticut
08795	Rayclad Tubes, Inc.	Redwood City, California
09097	Electronic Enclosures, Inc.	Los Angeles, California
09145	Atohm Electronics	Sun Valley, California
09772	West Coast Lock Washer Co.	Downey, California
09985	Troxel Corp.	Elkhart, Indiana
10003	Grant Pulley and Hardware Co.	Los Angeles, California
11115	Tung-Sol Electric, Inc.	Bloomfield, New Jersey
11237	Chicago Telephone of California, Inc.	Pasadena, California
11769	Elco Pacific	Los Angeles, California
11837	Electro Scientific Industries, Inc.	Portland, Oregon
11897	Plastiglide Mfg. Corp.	Santa Monica, California
11903	M. E. C., Inc.	Nashville, Tennessee
12060	Diodes, Inc.	Chatsworth, California
12406	Elpac, Inc.	Fullerton, California
12498	Crystalonics, Inc.	Cambridge, Massachusetts
12617	Hamlin, Inc.	Lake Mills, Wisconsin
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy Co.	Dallas, Texas
13812	DialCo Electric Corp.	Brooklyn, New York
14099	Semtech Corp.	Newbury Park, California

FEDERAL
SUPPLY
CODE

MANUFACTURER

ADDRESS

14655	Cornell-Dubilier Electric Corp.	Newark, New Jersey
14752	Electro Cube, Inc.	South Pasadena, California
15318	Cimron Corp.	San Diego, California
15551	Kalpa Scientific Laboratories, Inc.	Flemington, New Jersey
15837	Motorola, Inc.	Arcade, New York
15849	UseCo, Inc.	Mount Vernon, New York
17109	Thermonetics, Inc.	Canoga Park, California
17227	Raytheon Co.	Mountain View, California
17452	Morgan Adhesives Co.	Stow, Ohio
17516	Moore, Maynard H. Jr., Inc.	Stoneham, Massachusetts
17826	Techno-Components Corp.	Northridge, California
17856	Siliconix, Inc.	Sunnyvale, California
18702	Ducommun Metals and Supply Co.	Los Angeles, California
18736	Voltronics Corp.	Hanover, New Jersey
21226	Executone, Inc.	New York, New York
24655	General Radio Co.	West Concord, Massachusetts
28480	Hewlett-Packard Co.	Palo Alto, California
28520	Heyman Mfg. Co.	Kenilworth, New Jersey
30874	International Business Machines Corp.	New York, New York
42190	Muter Co.	Chicago, Illinois
44655	Ohmite Mfg. Co.	Skokie, Illinois
46384	Penn Engineering and Mfg. Corp.	Doylestown, Pennsylvania
47904	Polaroid Corp.	Cambridge, Massachusetts
49671	Radio Corporation of America	New York, New York
53800	Sears Robuck and Co.	Chicago, Illinois
55026	Simpson Electric Co.	Chicago, Illinois
56289	Sprague Electric Co.	North Adams, Massachusetts
70331	Alpha Wire Corp.	New York, New York
70666	Automatic Products Co.	Detroit, Michigan
70903	Belden Mfg. Co.	Chicago, Illinois
71279	Cambridge Thermionic Corp.	Cambridge, Massachusetts
71468	I. T. T. Cannon Electric Co.	Los Angeles, California
71482	Clare, C. P. and Co.	Chicago, Illinois
71590	Centralab, Division of Globe Union, Inc.	Milwaukee, Wisconsin
71775	Cunningham, James, Son and Co.	Honeoye Falls, New York

FEDERAL
SUPPLY
CODE

MANUFACTURER

ADDRESS

71785	Cinch Mfg. Co.	Chicago, Illinois
72005	Driver, Wilber B. , Co.	Newark, New Jersey
72314	Fairchild Camera and Instrument Corp.	Syosset, L. I. , New York
72825	Eby, Hugh H. , Inc.	Philadelphia, Pennsylvania
73680	Garlock, Inc.	Palmyra, New York
73899	J. F. D. Electronics Corp.	Brooklyn, New York
74970	Johnson, E. F. and Co.	Waseca, Minnesota
75237	Kayner Mfg. Co.	Pico-Riveria, California
75594	Liberty Hardware Mfg. Corp.	New York, New York
75915	Littelfuse, Inc.	Des Plaines, Iowa
76005	Lord Mfg. Co.	Erie, Pennsylvania
76530	Monadnock Mills	San Leandro, California
76545	Mueller Electric Co.	Cleveland, Ohio
78277	Sigma Instruments, Inc.	South Braintree, Massachusetts
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78929	United States Plywood Corp.	New York, New York
79094	Victory Engineering Mfg. Co.	Millvale, Pennsylvania
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pennsylvania
79963	Zierick Mfg. Corp.	New Rochelle, New York
80095	Burgess Battery Co. , Battery Division	Chicago, Illinois
80112	G. C. Electronics Mfg. Co.	Los Angeles, California
80223	United Transformer Co.	New York, New York
80294	Bourns Laboratories, Inc.	Riverside, California
80368	Sylvania Electric Products, Inc.	New York, New York
80640	Stevens Arnold Co. , Inc.	Boston, Massachusetts
81073	Grayhill, Inc.	La Grange, Illinois
81541	Airpax Products Co.	Cambridge, Maryland
82042	Carter Precision Electric Co.	Skokie, Illinois
83330	Smith, Herman H. , Inc.	Brooklyn, New York
84171	Arco Electronics, Inc.	Great Neck, New York
86270	Bendix Corp.	Baltimore, Maryland
90002	Hubbel, Harvey, Inc.	New York, New York
90201	Mallory, P. R. and Co. , Inc.	Detroit, Michigan
91833	Keystone Electronics Corp.	New York, New York
92379	Burroughs Corp.	Chicago, Illinois

FEDERAL
SUPPLY
CODE

MANUFACTURER

ADDRESS

92607	Tensolite Insulated Wire Co. , Inc.	Tarrytown, New York
94222	South Chester Corp.	Chester, Pennsylvania
95264	Lynn Electronics Research Co.	Burbank, California
95348	Gordos Corp.	Bloomfield, New Jersey
95354	Methode Mfg. Co.	Chicago, Illinois
95566	Arnold Engineering Co.	Marengo, Illinois
97564	Pendar, Inc.	Coeur D Alene, Idaho
98291	Sealectro Corp.	Mamaroneck, New York
98978	International Electronics Research Corp.	Burbank, California

THREE-YEAR UNCONDITIONAL

WARRANTY

FOR PREMIUM LINE INSTRUMENTS

CIMRON hereby warrants to each original purchaser of an instrument designated by Cimron to be in its "PREMIUM LINE" as follows:

I. At the time of delivery of all "PREMIUM LINE" instruments to the original purchaser thereof, Cimron UNCONDITIONALLY WARRANTS that all of such instruments shall be free from defects in parts, materials and workmanship; and

II. Commencing with the date of delivery of all "PREMIUM-LINE" instruments to the original purchaser thereof, which delivery date for purposes of this warranty shall be deemed to be Cimron's original shipment date, AND FOR A PERIOD EXPIRING THREE (3) YEARS FROM SAID DATE, Cimron UNCONDITIONALLY WARRANTS that all such instruments shall remain free from defects in parts, materials and workmanship.

In the event any "PREMIUM LINE" instrument shall fail to meet the terms of this warranty, Cimron agrees that if the original purchaser of any such "PREMIUM LINE" instrument shall:

- (1) Give to Cimron customer service department prompt notice in writing of the nature of any suspected defects; and
- (2) Upon receipt of written authorization and shipping instructions from Cimron, return the instrument with suspected defects, transportation charges prepaid, to Cimron's main plant located at 1152 Morena Boulevard, San Diego, California; then Cimron shall replace any and all defective parts or materials and shall repair any and all defective workmanship and shall return the instrument, TRANSPORTATION CHARGES COLLECT, in good working order and state of repair to the original purchaser thereof, or in the alternative, Cimron shall have the option to replace any such defective instrument by substituting a new instrument of the same type thereof, ALL WITHOUT ANY CHARGE WHATSOEVER.

The warranties herein contained shall not obligate Cimron in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection of the instrument by Cimron are not to Cimron's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship.

Cimron reserves the right to modify or change the design or appearance of any of its "PREMIUM LINE" instruments as it deems desirable. Nothing herein contained shall preclude such right or create any obligation to effect such changes on units previously purchased.

The remedies herein specified in the event of a breach of any of the warranties herein contained shall be the sole and exclusive remedies for such breach.

The warranties herein contained are intended to be and shall be construed as being in addition to and cumulative to all implied warranties contained in the Uniform Commercial Code, provided, however, that in the event of any breach by Cimron of any of the implied warranties contained in the Uniform Commercial Code neither the purchaser of any Cimron product, nor any other person, shall be entitled to recover by reason of such breach any incidental damages or consequential damages as those terms are defined in subsection 2-715 of the Uniform Commercial Code.

All warranties herein contained shall run only in favor of the original purchaser of Cimron's "PREMIUM LINE" instruments and all such warranties shall immediately terminate and become null and void and of no further force or effect whatsoever upon the sale or other transfer of any such instrument by the original purchaser. The warranties herein contained constitute the sole and exclusive warranties made by Cimron of its "PREMIUM LINE" instruments and no other express warranties not herein contained are given and no affirmation of fact, promise or representation made by any agent, employee or representative of Cimron shall constitute a warranty. No agent, employee or representative of Cimron has any authority to bind Cimron in any affirmation of fact, promise, representation or warranty not herein expressly contained.



CIMRON
DIVISION



LEAR SIEGLER, INC.

